THE

ANATOMY

OF THE

HUMAN BODY.

IN FOUR VOLUMES,

ILLUSTRATED WITH ONE HUNDRED AND TWENTY-FIVE ENGRAVINGS.

VOLUME III.

CONTAINING THE

NERVOUS SYSTEM.

PART I.

THE ANATOMY OF THE BRAIN, AND DESCRIPTION AND COURSE OF THE NERVES.

PART II.

THE ANATOMY OF THE EYE AND EAR; OF THE NOSE AND ORGAN OF SMELLING; OF THE MOUTH AND ORGAN OF TASTE; OF THE SKIN AND SENSE OF TOUCH.

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NEW-YORK:

PRINTED AND SOLD BY COLLINS AND PERKINS, NO. 189. PEARL-STREET.

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1809.

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INTRODUCTORY VIEW

OF THE

NERVOUS SYSTEM.

THERE can be no natural division of the nervous system, for it is a whole so connected in function, that no one part is capable of receiving or imparting any sensation, or of performing the operation of the intellect.

The system has, notwithstanding, been arbitrarily divided into the brain and nerves; the brain being subdivided into the cerebrum, cerebellum, and medulla oblongata; while the nerves are subdivided into the nerves of the senses, the vital and involuntary nerves, the nerves of voluntary motion.

The BRAIN is defined to be that soft mass contained within the cranium, from which the nerves are propagated to the organs of the senses and over the body, bestowing sensation, and acting as the agents of the will. It is believed to be the receptacle of sensation and the instrument of thought; but our ideas of its functions are vague and imperfect.

The substance of the brain is delicate and soft, and possesses a degree of elastic resistance; but the nerves are firm, hard, and devoid of elasticity; because, though their peculiar substance has equal delicacy with the brain, their membranes give them firmness and strength to enable them to pass through the moving parts of the body without being bruised, or having their function affected. The substance of the brain is protected and supported by the scull and dura mater: its peculiar matter is supported and nourished by the pia mater. The nerves contain the same matter with the brain; but in their course through the body this matter is disguised by the peculiar structure of their membranes, which, while they support their substance, nourish them also, as the membranes do the

brain. But the extremities of the nerves are again reduced to the same delicate texture with the brain.

In the structure of the brain and nerves there is an analogy with the other parts of the body. In a bone or a muscle there is the same intexture of membranes supporting the peculiar substance which is the characteristic of the part, and conveying blood vessels for its nourishment. The muscular fibres, or the earth of bone, are, in the midst of this investing membrane, peculiar parts distinct in their properties, as the medullary substance of the nerves is amidst the cellular membrane, which divides them into fasciculi, and gives them their fibrous appearance.

When it is said that the nerves are productions of the brain, we are not to understand that they are propagated from it to the distant parts of the body, as if drawn out from it like a thread from the wool. In the embryo the nerves are laid in their sheaths, extending to the remotest parts of the body.—They are connected with the brain, and in this sense they may be considered as elongations of it, the perfect function of both depending upon their union. But they have powers independently of the brain; and often an animal is produced having no brain; and yet, in such embryo, the animal functions are sufficiently perfect.

In the same manner, when the trunk of the nerve of a limb is cut, it is only deprived of its connection with the brain, the centre of the nervous system; and little further effect is produced than the destruction of the powers of the will over the limb; the nutrition and growth of the part continue, and the action of those parts, which are independent of the will, as the muscular power of the vessels of the limb, remains entire.

The nerves of animals are in proportion to the size of their bodies; but in many of the great tribes of animals the brain bears no such proportion. The nerves of the organs also bear a relation to the necessities of the animal, not to the size of the brain. If the procuring of sustenance depend upon the power of the organ of smelling, or upon the ear, or the eye, or even the bill, an additional supply of nerves is provided, or a peculiar apparatus of nerves suiting to the exigency. This also shews a property in the nerves independent of the brain.

We come to this conclusion, that the nerves are analogous to the brain, (being indeed a matter similar in structure and function to it,) diffused over the body, and included like it in the pia mater, or in a similar delicate and vascular membrane, and that their proper substance, consisting like the brain of a cineritious and medullary matter, is nourished by these membranes. We must conclude also, that they are more indepen-

dent of the brain than the brain is of them ; for the nerves are capable of continuing the operations of the animal body independently of the brain ; but without the communication of sensation through the nerves to the brain, its function must be unexercised.

The nerves, in their course through the body, form ganglions, plexus, and networks. By these a more universal connection of the several branches of the system is maintained, so that few if any nerves can be traced to one point or origin.—When the nerves form ganglions, (which are like knots or swellings upon them,) their fibres are split and irregularly dispersed, while there intervenes a peculiar substance resembling the striæ of the cineritious substance in the brain. From every analogy we must suppose, that those ganglions answer in a less degree the purpose of that more universal connection which the nerves have with the brain.

In their extremities again the nerves are peculiarly organized : a nerve, in its course, is incapable of receiving any distinct sensation ; when injured, it conveys to us the undefinable sensation of pain ; and from the connection with the muscles, and with the whole system, it shakes the limb with involuntary tremors, or sudden spasms. The susceptibility of those peculiar impressions which the organs of the senses convey, depends upon a structure distinct from that of the brain, and distinct also from that of the nervous cords ; and this organization is so peculiar, that the nerves of one sense are quite incapable of receiving the impressions which those of another are fitted to convey, though apparently to our reasoning those impressions appear to be capable of producing a stronger effect upon the nerves.

As the vital organs must be in perpetual action to support life, nature has guarded those functions by making them independent of the will, and less immediately dependent on the function of the brain. This is a provision which allows the exhausted mental and bodily functions to be recruited by sleep, while the operations of the animal body necessary to life go on uninterrupted.

It is an additional reason for believing the use which we have assigned to the plexus and ganglions to be the true one, that those nerves which supply the vital organs arise by small twigs from the brain, take a long course through the body, and neither swell out into large nerves, nor are finally distributed until they have received many additions, and formed several remarkable plexus and ganglions.

As in sleep the vital functions continue uninterrupted, so the diseases of the brain, which resemble sleep, suddenly de-

prive the body of all voluntary exertion, while the vital motion remains for a time unimpaired, and sinks gradually; for no part of the body is altogether independent of the healthy function of the brain.

It is necessary also that we should recollect the connection of the higher attributes of a living being with the animal economy.

The brain, the nerves, and the nervous expansions in the organs of the senses, are dependent for the perpetual renewal and support of their function upon the circulation of the blood. We should be tempted to imagine, that the nervous system were a nobler part of the economy, did we not frequently see the powers of the mind as well as the functions of the nerves disturbed, or altogether overthrown by the irregularities of the bodily system; were we not thus reminded of that circle of connections and mutual dependences which support the whole. If the tide of blood flow too rapidly upon the brain, the intellect is disordered, the ideas come in rapid and irregular succession. If the exit of the blood from the head be obstructed, there is an obstruction to the circulation of the blood in the extremities of the vessels of the brain; the function of the brain is suddenly suppressed, because, though its attributes seem so peculiar, it requires the perpetual circulation of the blood through it to renovate its powers.

The effect of the circulation of the blood through the nerves of the limb is not less remarkable. If the nerve of a limb be cut or tied, the animal can no longer move the limb, having lost the power of the will over it. But if the great artery of a limb be tied, the function of the nerve is, in a short time, equally destroyed, because the circulation of the blood through the nerve being obstructed, it loses its powers, and is no longer a living part.

Thus, whilst the moving powers of the circulation of the blood are dependent on the state of the nervous system, the nervous system is as immediately dependent on the healthy state of the blood, and the velocity of the circulation.

With this general view of our subject, we proceed to investigate the anatomy of the brain as a distinct part, without forgetting the unity of the system.

A. A. *Hemispheres of the Cerebrum.*—B. *Corpus Callosum.*—C. *Rapha.*

CHAP. I.

OF THE MEMBRANES OF THE BRAIN, AND OF THE SUBSTANCE AND TEXTURE OF THE BRAIN ITSELF.

OF THE DURA MATER.

MANY authors, while they describe the cranium as containing the brain, conceive that it also gives it shape. But the brain is formed before the bones which invest it. The first thing that we observe in the embryo is the disproportionate size of the brain to the diminutive body. The ossification of the bones of the scull is a gradual process. The brain, already

formed, is invested with the strong membranes ; and betwixt the laminæ of the outer membrane, the points of ossification commence, and are not completed until the ninth year. The bony matter, which is deposited betwixt the layers of this membrane, retains a firm connection and interchange of vessels with the now apparently distinct membranes on its inner and outer surfaces. The outer layer, which is so strong in children newly born, becomes the delicate pericranium, whilst the inner layer is the dura mater. Thus we find that the bones of the head are moulded to the brain, and the peculiar shapes of the bones of the head are determined by the original peculiarity in the shape of the brain.

This view corrects an error into which many have fallen, that the dura mater and the vessels ramifying upon it impress their form upon the solid bones, and wear channels upon their surface by their incessant pulsation. The membranes and vessels precede the formation of the bone, and the osseous matter is deposited so as to be moulded round the vessels.*

Thus the dura mater may be considered as the internal pericranium.†

The dura mater‡ is a firm and somewhat opaque membrane. When the scull-cap is torn off, and it is cleaned from the blood which escapes from the ruptured vessels, it is seen marbled with azure and rosy colours. It partakes more of the former in youth than in those advanced in years, or in the robust and sanguineous.§ Its outer surface is rough, from the adhesions to the bone being torn up ; but on the surface lying in contact with the brain, it is smooth, shining, and of a pearl colour.

Although the dura mater is really the strongest membrane of the body, it is yet divisible into laminæ ; these are strengthened and firmly connected by the intertexture of strong fibres. Most anatomists describe it as composed of two laminæ.—Some however describe three laminæ—the outer lamina, or squamosa ; the middle, or filamentosa ; and the internal (being smooth and uniform,) the lamina membranosa.‖—But to

* Albini Acad. Anat. " Quomodo cranium crefcendo accommodat fe eis quæ continet."

Fifcher, Differtatio de modo, quo, offa fe vicinis accommodant partibus.

† Some regard only its external lamina as the internal pericranium. Fallopius firft viewed the dura mater in this light, and he is followed by the beft anatomifts.

‡ The membranes of the brain have the name of *mater*, becaufe they defend the brain, and protect its tender fubftance, or, according to fome anatomifts of the Arabian fchool, becaufe the other membranes of the body are produced from them. Before Galen, the term Meninx was common to all the membranes of the body, afterwards it was appropriated to thofe of the brain.

§ Malacarne Encefalotomia Nuova, p. 19.

‖ Malacarne, p. 22. It is defcribed as partly tendinous, partly ligamentous :

the Scull cap of a Child before it be fully Ossified 1 the Fontanelle 2 the Pericranium extremely Vascular. 3 the Longitudinal Sinus opened by cutting up the membrane in the direction of the Sagittal Suture

separate the dura mater into such laminæ, it will, I believe, be necessary to dry it and tear it into shreds. No doubt it may be possible thus to tear it, as some have done, into four, six, seven, or even eight laminæ or squamæ. It is to be regretted that anatomists should have been proud of such dissections, or that any such descriptions should be thought creditable to their authors, or discoverers as they are called.

The dura mater is insensible; it has, in the way of experiment, been pricked and injured by every possible contrivance, by mechanical and by chemical stimulants; yet the animals, the subjects of such cruel experiments, have given no sign of pain*. Before this fact of the insensibility of the dura mater was thus established, physicians regarded this membrane as the seat and origin of many diseases†.

Formerly the natural connection of the scull and dura mater was so resolutely denied—so hotly contested among the various parties in anatomy and surgery, that we might, by reading their disputes, almost doubt one of the plainest and most obvious facts, were not the closeness of this connection sufficiently proved by the manner of the original formation of the cranium, by the resistance to the tearing up of the cranium, and by the bleeding surface of the dura mater; or, if further proof be required, we may macerate these bones and their membranes in acids, when the laminæ of the dura mater will be seen intimately connected with the bone, while the pericranium and outer laminæ of the dura mater are seen to be continued into each other‡, by the intermediate cellular texture in which the earth of the bones is deposited§.

The dura mater adheres more firmly to the bone in young subjects, because the bone is yet imperfect, and its surface spongy and rough; and, for the same reason, it is more firmly attached to the scull in the chronic hydrocephalus, because the ossification is imperfect.

that is to say, of a nature resembling these, yet not altogether the same. Vicq. d'Azyr found it separated by purulent matter into two laminæ, the fibres of which had a different direction. Acad. de Sciences, An 1781. p. 497.—Bartholin Sp. Histor. Anatomiæ.

* Zinn. Exper. circa corpus callosum, cerebellum, duram meningem.--Mem. par Haller sur les parties sensibles et irritables.—Bleguy Journal de Med. An 1. p. 16.

† See Hoffman. Med. Ration. part 2. sec. ii. c. 1. § 2. and Boneti Sepulch. Anat. lib. i. sec. 1.

‡ Vicq d'Azyr Memoir. de l'Acad. Roy. 1781, p. 497, and Malacarne (Aderenze della D. M. alle pareti interne del cranio), p. 24.

§ Taking a portion of the dura mater betwixt the finger and thumb, we can feel the two laminæ moving upon each other, from a slight degree of laxity in the connecting cellular substance. This cellular texture is demonstrated by Malacarne, by forcibly injecting quick-silver betwixt the layers of the membrane.

It frequently adheres so firmly to the scull-cap, as to leave its outer lamina adhering to the scull when it is raised. It adheres more firmly along the sutures, and from this cause, when the scull is injured, and matter is formed under it, the dura mater will be separated on each side of the suture, and still retain its adhesion to the suture, so as to divide the matter, and, consequently, prevent the full evacuation of the matter when the trepan has been applied on one side of the suture. The dura mater adheres also with peculiar firmness to the base of the scull, because of the numerous chinks and foramina.

GLANDS OF THE DURA MATER.

UPON the external surface of the dura mater there are little holes, from which emerge fleshy-coloured papillæ, and which, upon examining the scull-cap, will be found to have corresponding foveæ. These are the glandulæ Pacchioni*. They are in number from ten to fifteen† on each side, and are seen chiefly lateral to the course of the longitudinal sinus. These bodies were supposed by Pacchioni to be glands. When pressed they give out a fluid; but in this they do not differ from the loose common cellular membrane. As they are chiefly seen along the line of the great sinus, and are not scattered over the whole dura mater, their supposed use of moistening the surface of the membrane‡ is quite improbable; and, indeed, this is a part of that unfounded hypothesis which supposed an interstice betwixt the dura mater and scull, and ascribed motion to this membrane. The surfaces of the dura and pia mater, where they are in contact, being of the nature of the secreting surfaces of the investing membranes of the other viscera, require no such further aid in moistening them, or preventing their adhesion. Many glands are described by authors in the substance, and upon both surfaces of the membrane§. Of the bodies which adhere to the surface of the pia mater, and of those also which are to be seen in the sinuses, we shall speak afterwards, when considering the veins which enter the longitudinal sinus.

* See M. Littre Acad. Roy. des Sciences 1704, Hist. p. 32. art. 19.

† Haller, El. Phys. p. 106, Mem. par M. Vicq d'Azyr Mem. de l'Acad. Roy. 1781, p. 497.

‡ Viz. the opinion of Fantonius.

§ Malacarne, sec. 94.

ARTERIES OF THE DURA MATER.

This membrane must necessarily be supplied with vessels for its own nourishment, for that of the contiguous bone, and for the perpetual exudation of the fluid, or halitus rather, which moistens or bedews its internal surface. We may divide the arteries of the dura mater into anterior, middle, and posterior. The first proceeding from the ophthalmic and ethmoidal branches; the second from the internal maxillary and superior pharyngeal; the posterior from the occipital and vertebral arteries.

The principal artery of the dura mater, named, by way of distinction, the great artery of the dura mater, is derived from the internal maxillary artery, a branch of the external carotid. It is called the spinalis, or spheno-spinalis, from its passing into the head through the spinous hole of the sphenoid bone, or meningea media, from its relative situation, as it rises in the great middle fossa of the scull*. This artery, though it sometimes enters the scull in two branches†, usually enters in one considerable branch, and divides soon after it reaches the dura mater into three or four branches, of which the anterior is the largest; and these spread their ramifications beautifully upon the dura mater, over all that part which is opposite to the anterior, middle, and posterior lobes of the brain. Its larger trunks run upon the internal surface of the parietal bone, and are sometimes for a considerable space buried in its substance. The extreme branches of this artery extend so as to inosculate with the anterior and posterior arteries of the dura mater, and through the bones (chiefly the parietal and temporal bones) they inosculate with the temporal and occipital arteries‡.

The meningeal artery has been known to become aneurismal and distended at intervals, it has formed an aneurism, destroying the bones, and causing epilepsy§.

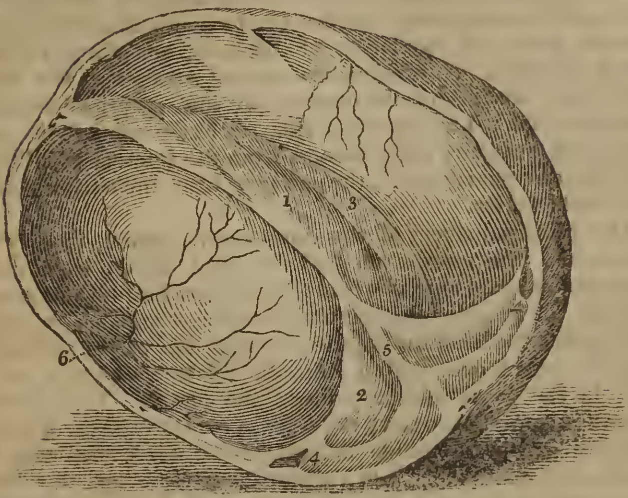
* Malacarne, parte i. sec. 100.

† Soemmerring de Corp. Hum. fab. tom. v. p. 142. This is not the sole artery sent to the dura mater from the internal maxillary, a twig also rises from that branch which goes to the pteregoid muscles and parts about the Eustachian tube—it enters the scull, and is distributed to the 5th pair of nerves, and to the dura mater and cavernous sinus. Another enters with the inferior maxillary nerve by the foramen ovale, and rises upon the dura mater.

‡ Malacarne.—" Antrorsum ramis arteriæ ophthalmicæ, retrorsum ramis arteriarum vertebralium, secuti etiam crebro sibi ipsi, nec non epicranii ramis, *e. g.* ex arteria occipitali ortis etc. in embryonibus potissimum conspicuis inosculatur." Soemmerring, tom. v. p. 142.

§ Malacarne, p. 1. sec. 105. " Possono le arterie, della D. M. devenire aneurismatiche, il che ho veduto in due cranii, in uno dei quali l'arteria spinosa era

The Scull Cap with the D. M. adhering.



1. *Falx.* 2. *Tentorium.* 3. *Longitudinal Sinus.* 4. 4. *great Lateral Sinuſes.* 5. *Fourth Sinus.* 6. *artery of the D. M.*

OF THE SEPTA WHICH INTERSECT THE BRAIN.

Those septa, or, as they are called, processes of the dura mater, being extended across from the internal surface of the cranium, support the brain in the sudden motions of the body,

tutta gozzi tanto a deſtra quanto a ſiniſtra, i maggiori dei quali (ed erano cinque dal primo, e nove dall' altero lato) poco ſuperavano la groſſezza dei piſelli: nell' altero ancor giovenile ſi vedevano due ſoli gozzi uguali in diametro al mignolo ſul tronco mezzano dell' arteria ſpinoſa rempetto alla metà del parietale ſiniſtro, diſtanti nove linee circa l'inferior anteriore dall' altro." Part i. § 105. We have alſo the following caſe from Malacarne. " Juvenis ætatis 22 annorum, ſanguinei temperamenti, poſt vehementiſſimos, et frequentes epilepſiæ motus in noſocomio D. Joannis, tumente in ſumma bregmatis oſſium parte capitis cute, ſub meis oculis moriebatur. D. Caccia in hac noſtra univerſitate tunc Botanices profeſſor, quem mihi patronum a morte peremtum adhuc defleo, ut cadaver aperiretur juſſerat, atque in ejuſdem capite ex ea parte, qua tenuiſſima devenerant oſſa, ob arteriarum ſubrepentium inter duræ matris laminas aneuriſmata, os quoque omnino deficiens reperiebatur, ſub capitis integumentis aneuriſmata magnitudinis ovi columbini, exiguo, perruptoque foramine aperto, ut ſanguis ſub integumentis concreviſcet; atque tunc novimus ad ea aneuriſmatum loca, quæ quidem utrinque erant, in vehementia morbi ægrum pugnos infligere conſueviſſe."—A curious caſe occurred lately to a friend of mine: A boy was wounded with an arrow in his head; it ſtuck in the parietal bone; upon withdrawing it, there was a profuſe hæmorrhagy, for its point had ſtruck the artery of the dura mater. The ſurgeon

and prevent the mutual gravitation of its parts. These partitions are formed by the internal lamina of the dura mater, which is reflected as the peritoneum is to form the mesentery, or the pleura to form the mediastinum.

The falx is the largest of the partitions; it is attached to the cranium in the line of the sagittal suture, and reaching from the crista galli of the ethmoid bone to the middle of the tentorium, or to the crucial ridge of the occipital bone, it passes deep into the middle of the brain, and divides it into its two hemispheres. It is in shape like a scythe, for anteriorly it does not pass so deep into the substance of the brain; but it gradually becomes broader, or descends deeper betwixt the hemispheres, as we follow it backwards, which, with the curve, it necessarily takes from the shape of the cranium, has obtained it the name of falx: it is also called septum sagittale, verticale, or mediastinum cerebri.

The TENTORIUM separates the cerebrum and cerebellum. It stretches horizontally over the cerebellum, and sustains the posterior lobes of the cerebrum. It is formed by the inner lamina of the dura mater, reflected off from the os occipitis along the whole length of the grooves of the lateral sinuses, and the edge or angle of the temporal bones. This septum, thus running round the cavity of the cranium, divides it into two departments; the upper one for the lodgment of the cerebrum, and the lower for the cerebellum. But to allow the union of these two great divisions of the encephalon, a circular opening is left upon the anterior part of the tentorium, which is called the notch of the tentorium.

There is a little process of the dura mater which may be called the FALX of the CEREBELLUM. It runs down upon the internal spine of the occipital bone from the tentorium, gradually contracting until it terminates on the margin of the great occipital foramen. It serves as a kind of ligament strengthening the tentorium, while it divides the cerebellum. It enters, however, but a little way betwixt the lobes.

The falx and tentorium being connected and continued into each other at their broadest part, they mutually support each other, and are extremely tense. This tenseness depends on their mutual support, for when one of them is cut the other falls loose.

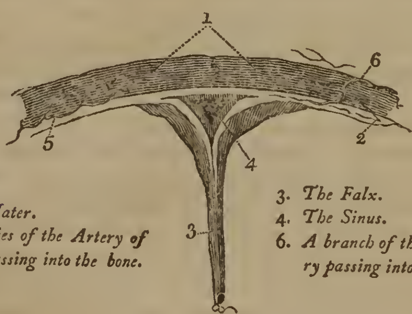
was cautious of applying preſſure, leſt the blood ſhould force its way betwixt the dura mater and bone, or diffuſe itſelf upon the ſurface of the brain; he bled the boy largely in the arm, but it had no effect upon the hæmorrhagy; and fearing to bring on a greater degree of inflammation by applying the trepan, he made a ſlight compreſſion, and in the now languid ſtate of the circulation, the bleeding was ſuppreſſed.

OF THE SPHENOIDAL FOLDS.

The lateral extremities of the tentorium are continued forward into acute lines, formed by the duplicature of the dura mater coming off from the edges of the pars petrosa of the temporal bones, and take firm hold on the posterior clynoid processes. From these two points a fold of the membrane stretches forward on each side to the anterior clynoid process, forming thus a hollow or cell for the lodgment of the pituitary gland. Another fold or duplicature of the dura mater runs onwards a little way from the edge of the little wing of Ingratius. These are the sphenoidal folds.

Where the internal lamina of the dura mater forsakes the external to form the falx and tentorium, it leaves a channel or triangular canal; the basis of which triangle is the lamina of the membrane investing the cranium, while the tension of the partitions carries the apex out into an acute point. This forms a channel for receiving all the blood of the veins, and this tension and triangular shape give a degree of incompressibility to the canals. These are the sinuses which receive the veins of the encephalon, and guard them from compression :—

Section of the Longitudinal Sinus.



1. *The Scull.*
2. *The Dura Mater.*
5. *The Extremities of the Artery of the D. M. passing into the bone.*
3. *The Falx.*
4. *The Sinus.*
6. *A branch of the Temporal Artery passing into the D. M.*

Upon the surfaces of the dura mater there are many lacerti, or slips of fibres, which are intricately interwoven with the main body of the membrane, and strengthen it. These fibres are peculiarly strong in the angles, where the duplicatures pass inwards, giving firmness to the sinuses, and allowing the veins to insinuate their trunks betwixt them; these fasciculi,

or slips of fibres, and the sides of the sinuses, are the cordæ Willisianæ. They were considered by Baglevi and Pacchioni* as the tendons of the muscles of the dura mater. Pacchioni conceived that this membrane was muscular. Vicq d'Azyr observes, that in inflammation of the dura mater he has seen it red, and of a fleshy appearance ; and that such a circumstance might have deceived Pacchioni, and made him believe that there were muscular bellies.†

These physicians conceived that the contraction of the falx and dura mater raised the tentorium ; they even conceived that the action of the heart depended upon this motion of the dura mater.‡ They were deceived by the pulsation in the arteries of the brain, communicated to the dura mater, after the operation of trepan, or in their experiments on living animals.§

The motion communicated to the dura mater those Italian anatomists conceived to depend on the rising of the tentorium. This motion, which is occasioned by the beating of the arteries of the brain, had been long before observed :|| some conceived it to be a motion in the brain itself, others believed it to depend on the sinuses.¶

The motion caused by respiration was likewise observed.** M. de Lamure's conclusion was, that the motion of the brain was caused by the reflux of the blood towards it from the vena cava in expiration.†† He undertook to demonstrate this ; and he conceived his proof to be good, when, by pressing the ribs of a subject, he saw the refluent blood swelling the jugular and abdominal cava. Haller observed the jugular veins swell, and become turgid, during expiration ; and he concluded, that the motion of the brain was occasioned by the refluent blood distending the sinuses of the brain. But he did not believe, as

* Thefe were Italian anatomifts. Pacchioni was phyfician to Clement XI.

† Mem. de l'Acad. Roy. 1781.

‡ Duverney.

§ There is a diftinction in the movement of the dura mater to be obferved upon opening the fcull ; one depending upon the pulfation of the arteries of the brain ; the other caufed by an obftruction to the exit of blood from the cranium, depending upon the lungs. " On voyoit bien la pulfation des arteres du cerveau, qui com-" muniquoicnt quelque mouvement à la dure mere, mais ce mouvement n'avoit " aucune fymmetric avec celui de la refpiration. Fatigué de ne rien voir après " avoir fi bien vû je comprimai la poitrine de l'animal : auffitot le cerveau fi gonfla, " evidemment par le reflux du fang de la poitrine qui rempliffoit la jugulaire.—Je " lachai la poitrine, et le cerveau redefcendit."—Exper. 78. Mem. ii. par Haller fur le Mouv. du cerv.—" Il arrivoit pourtant de tems en tems et fans que cela " continuat que le cerveau fe foulevoit dans l'expiration, et fe laiffoit repomper " dans l'infpiration." Exper. 79. f. chat.

|| By Coiterus, Riolanus, Bartholin.

¶ Diemerbroeck.

** M. Schlichting Mem. des favans Etrangers, 1744. Lorry, Mem. prefent. a l'Acad. des Scien. par divers favans Etrangers.

†† M. de Lamure ; vide l'Acad. de Sciences, 1744.

Lamure did, that this motion took place before the opening of the cranium, as well as after it.

When the scull is opened by a wound, the dura mater still protects the brain, resisting inflammation, and giving the necessary and uniform support to the more delicate substance and vascular membrane of the brain ; but when the dura mater is lacerated by the trepan, or punctured, or worn by the pulsation against the edge of the bone, there may be sudden hernia of part of the brain from coughing, or a rapid and diseased growth from the pia mater forming a fungus. Such fungus is, in some degree, peculiar to children, and is occasioned, I conceive, by the taking away of that due compression which the resistance of the dura mater ought to give.

OF THE PIA MATER.

WHILE the dura mater is closely connected with the cranium, and in contact with the surface of the brain, but still unconnected with it, except by means of veins entering the sinuses (and that only in the course of the sinuses;) the pia mater is closely attached to the brain, and passes into its inmost recesses. While the dura mater is firm and opaque, and not prone to inflammation, the pia mater is delicate, transparent, and extremely vascular. Like the dura mater, it is not endowed with sensibility ;* it is of great strength, considering its apparent delicacy.†

The pia mater, which was formerly considered as a simple membrane, consists, in reality, of two membranes, the tunica arachnoides, and the proper pia mater, or tunica vasculosa.‡

The TUNICA ARACHNOIDES was discovered and commented upon by a society formed by Blasius Sladus Quina and Swammerdam.§ They called it Arachnoides, because of its extreme tenuity. It was called also Membrana Cellulosa, from the appearance it took when they insinuated a blow-pipe and blew it up, separating it from the pia mater.

This membrane is without the pia mater ; and while the pia mater sinks down into the sulci of the brain, this covers the surface uniformly, without passing into the interstices of the convolutions, or into the ventricles.||

* Haller, Oper. Minor. de Part. Corpor. humani ſent. & irrit.

† Sir C. Wintringham Exper. Eſſays. Taken comparatively, it is ſtronger than the aorta.

‡ There are many, however, who with Lieutaud conſider the arachnoid coat as the external lamella of the pia mater.

§ This was in 1665. I am, perhaps, not correct in ſaying they diſcovered it ; for Varolius deſcribes it plainly, covering the medulla oblongata.

|| Haller Elemen. Phys. tom. iv. ſec. viii. p. 7.

This membrane is so extremely thin, that it cannot by dissection be separated for any considerable space from the pia mater, and least of all, over the middle hemispheres of the brain. By the blow-pipe, indeed, we may raise it into cells, but it immediately subsides again ; on the posterior part of the cerebellum, on the spinal marrow and base of the brain, it is more easily raised and demonstrated.* It does not pass deep into the sulci of the brain, but unites them by an extremely delicate cellular texture.

The view which would incline me to consider the tunica arachnoides merely as a layer of the pia mater is this : when the vascular pia mater descends into the sulci, the tunica arachnoides does not follow it, but keeps to the uniform surface of the brain ; but when this vascular membrane is about to enter into some of the lesser sulci which are within the larger, it again parts with another lamella, while its more vascular part descends still deeper into the brain.

OF THE PROPER PIA MATER, OR TUNICA VASCULOSA.

The pia mater is a simple membrane, without either tendinous aponeurotic or muscular fibres. It is extremely vascular, but it is transparent in the interstices of its vessels : it is the membrane which immediately invests and connects itself with the substance of the brain ; and although delicate, it forms the support and strength of its ceneritious and medullary substance. All vessels distributed in the body, however minute, are always conveyed in membranes ; the pia mater then follows, or rather conveys the vessels not only into the cavities of the brain, but to every part of its substance, it being intimately blended with it.† We see it more distinctly descending in strong plicæ into the interstices of the convolutions ; nor is it into them only that it enters, but into every pore which conveys a vessel.‡ The pia mater as it passes into the substance of the brain, divides and subdivides into partitions and cells, and every capillary vessel, and every molecule of the substance of the brain is invested and supported by its subdivisions. The pia mater is to the brain what the cellular membrane is to the other viscera

* F. Ruyſchii Reſponſio ad A. os Goelecke Epiſtol ix. See Bidloo, table 10 ; but the membrane is ſo delicate (nulla detur in corpore ſubtilior, Ruyſch) that it can be but very imperfectly repreſented by engraving.

† Columbus, the aſſiſtant of Veſſalius, and afterwards Profeſſor in Rome, explained this intimate intertexture of the pia mater with the proper ſubſtance of the brain, ſo far back as 1559.

‡ When we tear off the pia mater from the brain (for it cannot be called diſſection,) it does not adhere merely at the ſulci, but to the whole ſurface of the convolutions ; and every where ſmall veſſels enter, and with theſe veſſels deſcends alſo the lamina of the pia mater.

and parts of the body; for it is the peculiar matter lying in the interstitious cellular membrane (as in muscles, bones, &c.) that gives the peculiarity of character to the parts;* the cellular membrane itself is nearly alike in all; therefore, in my judgment, the pia mater is rightly considered by some anatomists as a cellular substance.†

Malacarne says, I am much inclined to consider it with the illustrious Haller, as being composed of lamina, like common adipose membrane, and that the extreme arteries ramify through its cells, for, with a blow-pipe, we can raise it into cells like the common membrane; and if this be carefully done, the air may be made to pass from cell to cell, following the arteries in their course betwixt the lobuli, and in the substance of the brain.‡ We can follow the pia mater into the ventricles, by tracing it betwixt the posterior lobe of the cerebrum and the cerebellum, where it forms the velum interpositum of Haller, and passes under the fornix. We can follow it also into the posterior horn of the lateral ventricles from the base of the brain, where the branches of the middle artery of the cerebrum pass into the lower part of the choroid plexus; we trace it also into the bottom of the fourth ventricle. The pia mater lining the ventricles is more delicate, and less vascular than that seen upon the surface, and betwixt the convolutions of the brain.

It has been said that the ventricles of the encephalon served to increase the surface of the pia mater, and that whatever purposes are served by that membrane and its vessels on the surface of the brain, we must suppose the same performed by it within the ventricles.§ This seems more like a weighty conclusion than it really is. We have seen how minutely distributed the pia mater is through the substance of the brain, independently of the ventricles; and we shall find that the ventri-

* "Sed cum continuo triduo in inquiſitione facienda perſeveraſſem; tandem deprehendi cerebri fibrillas eadem ratione, continuataque ſerie, ſibi invicem annexas eſſe; quemadmodum fibrillas carneas tendinibus adhærere demonſtravi; cum igitur illam cerebri cum vaſis ſanguineis connexionem deprehendiſſem; et eam, quam ante dixi, variorum fructuum compagem attenderem; iterum concluſi dominum, univerſi conditorem, in rerum creatarum fabrica eaſdem vel conſimiles fere leges tenuiſſe."—"Igitur adverti ſibrillas certo loco ſibi conjunctas, mox alio loco ab invicem divertere, paulo poſt iterum coëuntes. Et, ſi recte memini, conſimiles conjunctiones obſervavi in muſculis cordis," &c. Leeuwenhoek Epiſt. Phyſ. xxxiv.

† Bergen. Program de pia matre. See Haller Anat.

‡ Such is the profuſion of veſſels diſtributed to inconceivable minuteneſs, that it has been conſidered as entirely compoſed of veſſels, and received the name of chorion, from the membrane of the ſecundines. Galen de uſu part. l. viii. cap. 8.—Malacarne, part 1. ſec. 243.

§ Dr. Monro's Nervous Syſtem, chap. vi.

cles have important uses, without the necessity of supposing them so subservient to the distribution of the pia mater.

As the tunica arachnoides is of a peculiar nature, and has few if any vessels, and as it covers the external surface of the brain only, it seems to me probable that this membrane is the cause why effusions in the ventricles are so common, and why fluids are so seldom found betwixt the surface of the brain and the dura mater. When by the diseased action of the vessels of the pia mater on the surface of the brain an effusion is thrown out, it very seldom lies upon the surface unconfined; but frequently fluids are contained in sacs of the arachnoid coat, betwixt the convolutions of the brain, or raise it into pellucid vesicles upon the surface. The want of a tunica arachnoides upon the pia mater of the ventricles, may be a cause of the fluids being so much more readily secreted into them.

The raising of the pia mater into vesicles by the action of the vessels of the pia mater, is rather an argument for the distinct nature of these membranes. The tunica arachnoides is raised by the action of the vessels of the pia mater, as the cuticle is raised into blisters by the inflammatory action of the vessels of the cutis, while no other membranes of the body take such an appearance in their disease. They inflame, indeed; they thicken; their lamina become more distinct, or their cellular substance fills with water, or hydatids are formed in them; but this appearance of water secreted under the tunica arachnoides is quite peculiar.

Section of the right Hemisphere.

1 *Central Medullary Matter*.....2 *Cineritious or Cortical Matter.*

OF THE SUBSTANCE OF THE BRAIN.

The cerebrum and cerebellum consist distinctly of two very different substances; the cineritious and medullary matter.—

The cineritious, or ash-coloured matter, forms the superficial or outer part of the encephalon, and is therefore called also the cortical part. The cineritious matter varies much in colour; in the crura cerebri it is very dark; in the pons varolii it is redder; in the corpora olivaria* it is yellower. The consistency of this matter also varies considerably in different parts; it is soft in the base of the brain, betwixt the optic nerves and anterior commissure, and in the third ventricle. The medullary matter is chiefly in the internal part of the brain, forming a kind of nucleus or white central part; but in many parts of the brain, there is a mixture of these which form striæ;† and in some of the eminences, the internal part is cineritious, while the external part, or what we might here call the cortical part, is medullary.‡

The cortical or cineritious substance does not blend gradually with the white medullary matter, but on the contrary, their line of distinction is abrupt: an intervening substance has been observed. In inflammation of the brain, particularly, it has been said, that this third substance has been found. This may be merely the effect of light upon the union of the two substances. We, however, often observe an appearance of successive coloured circles upon the edge of the medullary matter of the arbor vitæ, in the cerebellum.

It has been asserted by M. Ludwig,§ that the masses and striæ of the cineritious substance, dispersed through the internal parts of the brain, have a communication with each other. This, however, is denied by Vicq d'Azyr.‖ He conceives, that the cineritious substances of the pons varolii, or of the corpora olivaria, have no communication with the cineritious substance in any other part of the brain; and that in several parts of the brain the cineritious substance is surrounded and isolated by the medullary matter. Its great importance (which

* Vicq d'Azyr.—" Exterior cerebri totius facies, donec in ſpinalem medullam abeat, plerumque colore eſt ſubrubride cinereo, vel languide ruſſeo. Fuſciora ſunt cerebra ſanguine ditia, *e. g.* hominum apoplexia enectorum, vel hominum craſſioris ſanguinis; pallidiſſima vero ſunt cerebra hydropica vel hominum pituitoſorum vel hæmorrhagia mortuorum. Dubio procul color cerebri ſanguinis temperaturam ſequitur, et ideo pallidius eſt infantibus, quam adultis." Sommerring hum. corp. fab. vol. iv. p. 41.

† Thus the cineritious ſubſtance is mixed with the medullary matter in the corpus calloſum, in the corpora ſtriata, the thalami nervorum opticorum, in the tubercula quadrigemina, the immenentia mamillaria; in the crura cerebri; in the pons varolii; in the corpora olivaria, and medulla ſpinalis.

‡ " E xerampelina ſulla ſuperficie del cervelletto, e dei corpi ſcanalati quando non evvi aqua nei ventricoli; foſca nei talami de' nervi ottici, e nelle gambe del cervello, dove quà e là ſuole avere del nericante giallognola zolferina, e talvolta granadiglia, nelle eminenze olivari." Malacarne, parte ii. ſec. 15.

§ De cinerea cerebri ſubſtantia, Lepſiæ.

‖ Hiſt. de l'Acad. Roy. an 1781. p. 507.

should never have been doubted) has been deduced from its being so generally found towards the origin of the nerves.*

The cineritious substance seems to have a much greater quantity of blood circulating in it than the medullary substance. Its vessels come by two distinct routes, partly from the extremities of those arteries which appear in large branches upon the surface of the brain, and partly by vessels which penetrate through the medullary substance from the base of the brain. Ruysch and Albinus have made the most minute injections of this part of the brain. The former conceived it to consist entirely of vessels; but Vicq d'Azyr and Albinus found always, in their experiments, that a great proportion of it remained colourless after the most minute injection. It is, indeed, very improbable, that so soft a body should be entirely composed of vessels. How, for example, can we suppose the commissura mollis, or cineritious matter, on the sides and bottom of the third ventricle, or the almost transparent lamina, which we find in some parts, to be composed of vessels?

The white MEDULLARY SUBSTANCE appears to be a pulpy mass. We observe no peculiarity of structure in it towards the surface of the brain, where it is contiguous to the cortical matter; but towards the origin of the nerves it takes a more fibrous appearance. This appearance of fibres is not owing to any peculiarity in the medullary matter, but to the manner in which the pia mater involves it. The medullary matter, being chiefly internal, has every where through the brain a communication from the fore to the back part, from the upper part to the base: from the great central part it extends in form of striæ, into the corpora striata and thalami; it invests the eminences in the lateral ventricles; and those upper parts have communication with the medullary substance of the base.

M. Meckel found, upon comparing the brains of an European and of a negro, that the medullary matter differed very much in colour. In the negro, instead of the whiteness of the European, the medullary matter was of a yellow colour, and nearly like the cineritious matter: he observed also, that this very peculiar distinction of colour was only to be observed

* Il faut que les uſages de la ſubſtance griſe ſoient tres-importans; car independamment de la portion de cette ſubſtance que les circonvolutions contiennent, et qui ſemble appartenir à la maſſe blanche du cerveau, ou en obſerve des amas plus ou moins conſiderables pres des diverſes origines des nerfs: ainſi pres de la premicre et la deuxieme paire, ſont les corps ſtries et les couches optiques; la troiſieme paire eſt pres d'un eſpece noiratre que je decrirai ailleurs; la quatrieme paire fort au deſſous des tubercules quadrijumcanx, dont le noyau eſt composé de ſubſtance griſe, la cinquieme, la ſixieme, la ſeptieme, ſe trouvent aux environs de le protuberance annulaire, ou la ſubſtance griſe eſt mêlée avec la blanche; la huitieme et la neuvième ſont placées près de l'eminence olivarie, où j'ai obſervé un mélange particulier de ſubſtance griſe. Mem. de l'Acad. Scien. an 1781, p. 507.

when the section was recently made, and that the darker colour of the medullary matter became fainter when exposed to the air*.

OF THE OBSERVATIONS MADE UPON THE MINUTE STRUCTURE OF THE BRAIN.

THE opinions regarding the structure of the brain have had a dependence on the general doctrines of the structure of other secreting organs, and it is, of course, connected with the disputations of Malpighi and Ruysch, because the doctrine of the glandular nature of the brain, and the belief of the nervous fluid being a secretion, has, in all ages, formed the basis of the most favourite theories†.

Malpighi found, on throwing in black and fluid injection, that there remained always particles colourless, and to which the injection did not penetrate. He conceived these to be glandular follicules, and that the cineritious substance of the brain consisted of this follicular or glandular structure, while the medullary matter of the brain was merely the fibrillæ of the excretory duct. This opinion was founded on conjecture, with but a very poor shew of experiments, viz. by boiling the substance of the brain in oil, he found it take a granulated appearance, as if formed of small grains, or little glands‡.

Such was the received opinion until Ruysch, with a despotical authority, swayed the opinions of physiologists: he alleged, in proof only his own experiments and preparations, in which other anatomists could not follow nor refute him, and therefore

* "La moelle du negre etoit d'un jaune clair, tirant un peu ſur le gris, tandis que celle de l'Europeen etoit d'une parfaite blancheur." "Celui du negre etoit d'un jaune noiratre et celui de l'Europeen d'une couleur blanche—Prolongeant enſuit la diſſection jusqu' aux grands ventricules du cerveau j'ai coupé horizontalement les corps ſtries et les couches des nerfs optiques. C'eſt la où la difference a paru vraiment etonnante, le corps ſtrie dans le negre etant preſque de la couleur brune d'une ecorce d'arbre, au lieu que celui de l'Europeen etoit couleur de chair pale tirant au cendre," &c.

† Indeed this doctrine of the glandular nature of the brain has deſcended from Hippocrates—" Caput quoque ipſum glandulas habet cerebrum enim eſt ut glandulæ album eſt et friabile," &c.

‡ " Pedamentum, ſupra quod poſita eſt philia in qua conſervatur portio cerebri in liquore, quam decoxi in oleo olivarum per horas, ſicuti, facere aſſolet Dr. Vieuſſens. Ea autem plane *mutilis et perverſa eſt preparatis*, nam nihilum quidem vaſculoſi viſui occurrit poſt decoctionem in dicto oleo, et quod unuſquiſque tentare poteſt ita ut inventor neutiquam habendus ſit Dr. Vieuſſens Sc. quod cerebri cortex nil ſit, niſi extremitates vaſorum ſanguineorum: in ea autem nemo hactenus (quod ſciam) me imitari poterit aut anologum quid fecit." Ruyſch Theſ. An. x. No. xxxii.

they acquiesced. His most unanswerable and most insulting argument was " veni et vide*."

According to Ruysch, the cortical substance of the brain is entirely vascular, and has no appearance of a glandular or follicular structure ; nay, he conceived it to be entirely composed of arteries†. But as Malacarne observes, though we suppose the extremities of the arteries of the cineritious substance to be more minute than those which are distributed to the microscopical corpusculi of the smallest visible insect, there must still remain some part, which is not composed of vessels ; and in regard to the veins of the cineritious substance we may appeal to Albinus, who, from the substance of the brain, finds many veins connected with the arteries of the cineritious substance when he carefully lifts the pia mater. But there is this peculiarity in the distribution of the blood vessels of the brain, that, though the cineritious substance be the most vascular, yet, in the medullary matter, we see the vessels with large open mouths, and more distinct than in the cineritious substance. In following the blood vessels from the base of the brain into the medullary substance, we see them distinct, and of considerable magnitude ; but when they are about to enter the cineritious substance, they disperse into minute branches‡. In the same manner those arteries, which are carried into the sulci of the surface by the pia mater, branch into extreme minuteness before they finally penetrate the cineritious substance§.

Leeuwenhoeck‖ observed, in the cortical substance of the brain, a pellucid, crystalline, and to appearance oily matter ; he calls this, therefore, the substantia vitrea. When he had put a small portion of this under his glass, he saw a fluid,

* " Milites quando hoftium adventum audiunt, clamant ad arma ! ad arma ! fic ego dico hic ad vifum ! ad vifum !" Refponfio ad J. Ch. Bohlium.

† Vieuffens was latterly of the fame opinion, and is accufed of plagiarifm by Ruyfch. Accordingly, we find, that in fome parts of his works he defcribes the glands and ducts of Malpighi.

‡ Leeuwenhoeck faw, in the fubftance of the brain, but efpecially in the cortical fubftance, red blood veffels, but fo delicate, that he could not comprehend how the globules of the red blood could pafs along them ; and what appeared more particular, they were of a deeper colour than the red particles themfelves ; for, when feen fingly, they appeared to have very little colour. This he explained by an experiment made upon a certain little animal. After it had fucked blood very plentifully, he obferved, that the blood was broken down by digeftion, and conveyed through the limbs and horns of the creature, fo as to make it univerfally red. So here he conceives that the globules of the blood may be broken down and altered in their fhape to enter the minute veffels of the brain.

§ Malacarne, Part II. fect. 18.

‖ He was born in Delft, in Holland, 1632, and died 1723. He is celebrated for his microfcopical difcoveries ; his papers are chiefly in the Tranfactions of the Royal Society of London, about the year 1674.

which he at first conceived might have escaped from the globules that were necessarily cut by the knife. This fluid also he found to consist of very minute globules, thirty-six times less than those of the blood*. These small globules he conceived to have probably constituted a fluid, which, during the life of the animal, was moveable, and in vessels, though now in death congealed and fixed†. The colour of the cortical substance he found to depend upon the minute ramification of the vessels which were of a dark brown colour, while, in the medullary part, they were clearer and more transparent. Independently of this distinction of vessels, he could observe little difference in the medullary and cineritious substance; the refraction of the rays of light amongst the transparent globules being the cause of the whiteness of the former.

R. della Torre, in his microscopical observations, describes globuli in the brain; he says, that he saw them floating in a pellucid viscous fluid. But Prochaska‡ thinks Della Torre must be mistaken in this, for when he took a small portion of the brain, he saw it consisting of innumerable globules, which continued to adhere to each other, even after three months' maceration in water: and thence he concludes, that it could not be as R. della Torre conceived, that these spherical bodies move from the brain on towards the extremities of the nerves; nor do these bodies lie imbedded in a glutinous fluid (he continues) but they are connected by the extremely minute and pellucid sepimentæ of the pia mater, and by the vessels which pervade both the cortical and medullary matter, and which nourish as well as support and connect these corpusculi.

Prochaska cannot, from his own observations, determine whether these globular bodies be convoluted vessels, or what they are. R. della Torre had observed, that they were largest in the cortical part, less in the medullary substance, still diminishing in the medulla oblongata, and least of all in the nerves; but succeeding observation did not support this assertion§. Malacarne expresses himself to be nearly of the same opinion in regard to the vesicular structure of the cortical substance of the brain. The minute processes of the pia mater, says he, embrace and support the medullary substance, which

* Anatomica Contemplatio, 30.

† Among thofe globules, of which the brain is compofed, he faw alfo globules of the blood, which it was eafy to diftinguifh by their roundnefs. Thefe red globules, he fuppofes, had efcaped in confequence of the minute veffels having been cut by the knife.

‡ Tract Anatom. de Struct. Nervorum.

§ This was certainly a theoretical deception: it is like the accurate obfervation of Tracaffati, who could diftinguifh a difference of tafte in the medullary and cineritious fubftance of the brain.

is surrounded with a matter of a darker colour, and less distinctly fibrous, but not less essential, and which is composed of corpuscules, that, in figure and arrangement, resemble the vesicles of the pulp of a lemon.*

Many authors endeavour to support their conjectures regarding this vesicular structure of the brain by morbid dissection.† We see the brain frequently degenerated into hydatids, or into little vessels, or into knobular glandular-like schirrosities. I have seen this vesicular appearance in great portions of the pia mater. I have seen the pia mater with innumerable little bodies like milliary glands upon it; and also the whole upper and external part of the brain degenerated into one mass of disease. It was hard, schirrous, tuberculated, and like a diseased gland.‡ But I cannot conceive that any conclusion, in regard to the natural structure of the brain, can be drawn from such appearances. They are to be considered as the diseases of the vessels and membranes rather than of the peculiar matter of the brain.

When the brain is examined in the fœtus of the early months, although the substance of the brain is extremely soft, and even of a fluid consistence, the membranes and vessels are fully formed, exquisitely minute, and perfect in all their processes, so that they give form and firmness to the brain. We see, consequently, that the due increase and complete organization of the brain is a gradual process, and like the growth of the other parts of the body.

OF THE SENSIBILITY OF THE SUBSTANCE OF THE BRAIN.

It cannot but appear strange, that the very source or centre, to which every sensation is referred, should itself be destitute of sensation; yet, we are assured, by the experiments of Haller and Zinn, that the cortical substance of the brain has been irritated, without the animal being convulsed, or giving signs of pain;§ but when the medullary part of the brain is irritated, the effects are instantaneous, and the animal is convulsed. It has been observed, that as the injury of a nerve causes convul-

* Malacarne, page 2. sect. 4.

† Wepfer de cicuta aquatica. Mangetus.---Malacarne, &c.

‡ There has been observed a structure like the bronchial gland. Huber, Observationes Anatom.---Acta Helvetica, 1758. Tom. iii.

§ But, like the insensible membranes, it becomes irritable by disease; or by pressure, which affects the universal function of the brain. Vander Linden, in his Medicina Physiologica (1613,) brings proof of the insensibility of the brain.—See the general enumeration of the effects of wounds in the brain. Haller Physiol. Tom. iv. &c. Observations par M. de la Peyronnie de decouvrir la partie de cerveau ou l'ame exerce les functions.—Acad. Roy. des Sciences.

sions, so does that of the central parts of the brain, from which the nerves originate ; but this sensibility* diminishes towards the surface of the brain.† We see a distinction betwixt the structure and function of the nerves and of the brain ; or rather betwixt the cineritious substance of the brain and the nerves. For, although we must necessarily conclude, that the cineritious substance is an important and, perhaps, the most essential part of the system, still it does not evince, by the immediate effect of injuries, that strict sympathy and universal connection which belong to the nerves.

The nearer to its source that a nerve is pricked the greater is the effect of the injury. As it recedes from its origin towards the superficies of the brain, the effect is lessened, because the connections of the part are diminished in number, proportionally to their distance from the central parts of the brain ; a puncture in the centre injures more filaments from their being concentrated to form nerves.

Several ounces of the brain have been lost in consequence of wounds, without death, or loss of memory, or intellect.

There is a very marked distinction betwixt puncturing, cutting, or even burning, the surface of the brain, and pressing it. In the first there is little or no effect, or even pain. In the latter there is stupor, pain, or convulsions. The reason is, that in the first it is a local irritation in a place which has little, if any, feeling, while in the latter, the effect of the pressure spreads extensively.

No sensible man will expect, in the most minute and unwearied investigation of the structure of the brain, to find the explanation of it's function. It is interesting to find effects so peculiarly connected with the operations of the mind, depending upon a structure of so gross and animal a nature as this of the brain, so far as we have seen ; but still, all explanation of those operations must be visionary.

* It is an effect different from pain or sensation : it shakes the body with violent convulsions.

† Sommering, tom. iv.

CHAP. II.

OF THE VEINS AND SINUSES OF THE BRAIN.

THE brain is very profusely supplied with blood, in so much, that the blood has been supposed to circulate in the brain in a proportion four times greater than in any other part of the body. This is the most moderate calculation, and it has been formed from a comparison of the quantity of blood circulating in the head, with that which circulates in the arm. Boerhaave and Kiel, comparing the area of the arteries of the cerebrum with that of the ascending aorta, made a most erroneous calculation of the proportion of blood circulating in the brain, compared with that of the rest of the body. Had they compared the quantity of blood within the head with that of the lungs, of the liver, of the spleen, or of the kidney, the difference would have been less striking.

Wherever there is great arterial vascularity, we are sure to find also peculiarities in the venous system of the part; wherever we find an accumulation of tortuous arteries passing to a gland, we shall also find the veins tortuous and large; or wherever the arteries of a part take a diseased action, the effect of this action will be found most perceptible in the change which the veins undergo. In short, the effect of disease is

much more surely to be discovered in the venous than in the arterial system; and no where is this better exemplified than in the brain.

The following appear on the first view to be the most striking peculiarities in the veins of the brain; their size; the little connection they seem to have with the surrounding cellular membrane; and the inconsiderable support which they appear to receive from it; their having no valves; their being in their course distinct from the arteries; and lastly, their not being gathered into great trunks, but emptying themselves into the sinuses of the dura mater.

It is not easy to conceive how the veins of the brain should have been so much overlooked by the older anatomists; but from the dissections of Albinus, and the microscopical observations of Leeuwenhoek, we have authority for what is, perhaps, in itself sufficiently evident, that the veins of the surface of the brain are derived from minute ramifications conveyed in the delicate pia mater; and that these, as in the other parts of the body, proceed from the extremities of the arteries, without any apparent peculiarity in the connection betwixt the extremities of the arteries and the veins of the brain.*

The description of the veins of the brain, previous to their entering the sinus, has been neglected. I divide them into the external and internal veins of the brain, or those which emerge from its substance, and are seen upon the surface; and those which, coming chiefly from the sides of the ventricles, are convoluted in the plexus choroides, and terminate in the fourth sinus.

OF THE VEINS WHICH ARE SEEN UPON THE SURFACE OF THE BRAIN.

Vicq d'Azyr has been minute in his attention to the veins of the surface of the brain. He confirmed the observation, that almost all the veins which pass into the longitudinal sinus, open in a direction contrary to the stream of blood in the sinus.‡ These superficial veins of the surface of the hemispheres,

* The obſervation is trivial! but we muſt recollect, that Veſalius contradicted Galen, and affirmed, that the ſinuſes received alſo arteries which gave them their pulſation. This opinion was refuted by Fallopius, but adopted by Vieuſſens, Wepfer, and others, upon the idea of the facility with which injection paſſes from the arteries into the ſinuſes; while, on the other hand, Ruyſch conceived that the cortical part of the brain conſiſted entirely of arteries.

† From Vicq d'Azyr's table we ſhould be led to conclude, that the veins did not decidedly all open with their mouths oppoſed to the ſtream of blood. Ridley aſſerts, that one half open backwards. Santorini alſo obſerves great variation in the direction of theſe veins. Lower, while he obſerved this direction back-

are in number generally from ten to fifteen on each side.—They really do not seem to be worthy of the minute attention which Vicq d'Azyr has bestowed upon them; he has most carefully described each individual branch, and that not in general terms, but first those of the right, and then those of the left side. Now, although these veins do not enter the sinus opposed to each other, nor in pairs, still the irregularity is trifling, and were it important, does not admit of description.—Those veins do not lie in the sulci of the brain, but pass occasionally along the interstices, or over the convolutions of the brain; they take in general a course from before backwards, but previous to their entering the sinus, are turned forwards. We have already observed, that the pia mater and dura mater have no connection, but at the place where those veins enter the lamina of the dura mater; and here their connection is somewhat peculiar. It is not a simple adhesion of the pia mater and dura mater; but a white spongy substance seems to connect and strengthen them, and, when torn asunder, it leaves a soft fatty kind of roughness upon the pia mater. These appear to me to be the same bodies which Ruysch so frequently mentions as little particles of fat, and which others have taken to be the glands of the pia mater.* Vicq d'Azyr, in his xxxiiid plate, fig. 14, has confounded them under the name of the glandulæ Pacchioni.† Of these veins lying upon the surface of the brain, there is one, or very often there are two large veins on each side, and which enter generally pretty far back in the sinus, and are somewhat peculiar from their greater size, and their semicircular course. These, from their state of dilatation, and the colour and fluidity of their blood, will be

wards, deſcribes them, at the ſame time, as paſſing obliquely betwixt the coats, like the gall duct in the inteſtine, or the ureters into the bladder. Sabbatier ſays decidedly, that they enter with their mouths oppoſed to the courſe of the blood in the ſinus. From Malacarne, we ſhould be led to conceive (what I believe to be the truth) that they open very irregularly. "Non tutte queſte vene ſboccano obliquamente ad un modo nel ſeno, come non a tutte la membrana interna del medeſimo ſomminiſtra quella valvuletta, che pure a modi lingua, di briglia, di mezza luna frequentemente ne ottura la meta, il terzo, o minor parte degli orifici." Malacarne, p. 94.

* "Portio piæ matris in liquore, cujus ſuperficies exterior obſita variis particulis prominentibus exiguis, quas pro glandulis habuerunt nonnulli: cum autem ſint diverſæ formæ, et colore pinguidinem repræſentent, pro pinguidine potius illas habeo præſertim cum inter duplicaturam piæ matris aliquoties pinguidinem invenerim." Theſaurus Anat. ix. No. xlii. Epiſt. ix. p. 8. Thes. v. No. 1.

† We ſee alſo what he ſays in the Acad. of Sciences, An. 1781, p. 502. "Elles étoient plus ou moins recourvertes, vers leur inſertion par les glandules de Pacchioni; les ayant examinés dans pluſieurs ſujets, j'ai obſervé qu'elles étoient a peu-pres, de chaque côté au nombre de dix, douze, ou quinze." "Ridley calls theſe carnous adneſcences," betwixt the membranes, p. 8. As to the gland which Willis affirms to be ſcattered over the tunica arachnoides, I could never ſee them.—Ridley.

found in morbid dissection, to mark sufficiently, in many instances, the character of the venous system of the brain. There is again another vein somewhat peculiar in its course: whilst those take a superficial course, and are upon the level of the longitudinal sinus, it gathers its branches upon the internal flat surface of the left hemisphere, and rises so as to insinuate itself into the inferior part of the sinus*. All these veins of the surface of the cerebrum have very free inosculations with each other.

I cannot any where better observe the negligence of authors, in regard to the glandulæ Pacchioni, than when speaking of the mouths of those veins which open into the great longitudinal sinus.

I cannot help thinking, that many of our best authors have overlooked entirely the importance of the glandulæ Pacchioni; and many also have been entirely ignorant of them. We have already mentioned, that a few small bodies by no means constant nor regular, were to be seen upon the external surface of the dura mater, in the course of the longitudinal sinus, or at no great distance from it. We have mentioned also those fatty-like adhesions of the roots of the veins as they enter the sinus, and which rather belong to the pia mater. Both these are called the glandulæ Pacchioni improperly. The bodies which engaged Pacchioni and Fautonus in such violent disputes, are seen on the inside of the longitudinal sinus, and are connected with the opening of the veins†; they appear of a fleshy colour, projecting like papillæ, or like the granulations of a sore. Pacchioni says, "Ovorum instar bombycinorum apparent," which describes their conglobate appearance; but they are of a pale fleshy colour, which Pacchioni says is owing to their being surrounded with muscular fibres. I have added the plate of Pacchioni, and contrasted it with a more natural drawing of them. The preparation from which Pac-

* Vicq d'Azyr.

† "In longitudinali ſinu, immediate, ſub membranoſis expanſionibus, in areolis chordarum Williſianarum, quin et ſupra eaſdem chordas conſitæ ſunt innumeræ glandulæ conglobatæ, propria, et tenuiſſima membrana, veluti in ſacculo concluſæ; quæ racematim ut plurimum coeunt; raro ſparſim diſponiuntur: hæ glandulæ utrinque ad latera falcis meſſoriæ, ab ejuſdem apice ad baſis uſque poſticam partem miro prope modum artificio procedentes, dorſo lacertorum accumbunt, & partim ab horum fibris, partim ab iis, quæ a chordis emergunt, firmantur, atque invicem alligantur, ita ut non niſi lacerat acu disjungi poſſint." Vide Pacchioni, p. 126.

"Sinu longitudinali aperto, in conſpectum veniunt corpuſcula rotunda, & ſubrotunda, milii forma, (a clariſs. viro Pacchiono detecta) hæc magnitudinem aciculæ vulgaris caput haud ſuperant, niſi per miſcroſcopium introſpiciantur, aut ex duobus corpuſculis combinentur." Ruyſch, Thes. vii. No. xxxiv. From this we ſee how various the ſize of theſe bodies is. In the next paragraph he obſerves, "Vix et ne vix quidem ullum ex dictis corpuſculis videre poteſt."

The Longitudinal Sinus laid open & the Glandular Pacchioni seen

The exact Copy of Pacchioni's *Plate of the* Glands.

chioni had taken his plate, was previously macerated in vinegar. These bodies being soft and vascular, have allowed the minute injection to transude in some of the experiments of anatomists, which has given rise to the opinion of the actual communication of the arteries of the dura mater with the sinuses. As to their use*, I am in considerable doubt. Joan. Fautonus (in his letters to Pacchioni) conceives that they give out a fluid into the sinus, to dilute the venous blood†. Pacchioni describes ducts passing from them to the pia mater, (which are those connections that we have already remarked,) and conceives that they lubricate the surface, or communicate with the substance of the brain; and that they are pressed, and their secretion promoted by the motion of the chordæ Willisianæ, and the action of the dura mater‡.

I should rather conceive that they had a valvular action on the mouths of the veins; they project from the mouths of the veins into the sinus, and the blood passing from the veins must filter through them, and be checked in its retrograde course, and perhaps obstructed in its natural course when they are enlarged. As these bodies differ very much in the variety of subjects, they must sometimes impede the free egress of the blood from the veins of the cerebrum into the longitudinal sinus, and cause disease, especially as they are softer and larger in old men§. At all events, they are too much overlooked in morbid dissection.

The veins which answer to the arteria corporis callosi, and which are seen lying upon the corpus callosum in a very fine cellular membrane, rise and pass into the inferior longitudinal sinus, that which is formed in the lamina of the inferior edge of the falx.

* It is curious that thefe bodies are confined to the longitudinal finus. "Mirum, & æque animadverfione dignum eft, hafce glandulas ad folius longitudinalis finus latera reperiri cum in lateralibus finubus vel nunquam, vel raro admodum per pauca earundem veftigia adnotentur, ubi præfertim præfati canales deorfum inclinare incipiunt, antequam ab interfeptorum dorfo difcedant." Pacchioni, p. 127.

† "Ego aqueum humorem in glandulis egregari, fluere lympham in tubulis, quos tecum lymphaticos appello, nunquam negaverim, fed liquidi fluxum ab utrifque verfus finum magis quam verfus ambitum cerebri verifimilem, magifque naturæ legibus confonum effe affirmo." Fautonus Epift. D. A. Pacch. Oper. Pacch. 177.

‡ "Ex iis autem in minimum quidem vafculum lymphaticum prodire confpicere potui." Ruyfch.

§ "Fibris carneis tenuiffimis circumambiuntur fingulæ, unde colorem carneopallidum nancifci videntur: in fenibus vero, in quibus hujufmodi fibræ enervatæ nimis laxantur, et ferme difparent, glandulæ albefcentes, & magis turgidæ cernuntur: quod, & in hydrocephalicis, comatofis, & id genus aliis obfervari poffe arbitrarer." Pacchioni Oper. p. 126, 127.

OF THE INTERNAL VEINS OF THE BRAIN, AND OF THE CHOROID PLEXUS.

Under this title of the internal veins of the brain, the choroid plexus comes naturally to be considered.

The Choroid Plexus and Vena Galeni taken from the Brain and spread so as to show their connection.

1. *Choroid Plexus of the right Side.* 2. *Plexus of the left Side spread out.* 3. *Arteries to this part, where it lies in the interior horn.* 4. *Plexus of the 3d. Ventricle formed by the Junction of* 1. 2. 5. *Vena Galeni.*

The most remarkable thing in the ventricles of the brain is, that they have lying in them this very peculiar vascular structure, the choroid plexus. The lining membrane of these cavities is extremely thin and smooth, insomuch, that some anatomists have denied its existence ; but through the whole ventricle there run certain folds or plaits of this membrane, which are so loaded with vessels as to resemble a fleshy substance, and to lose altogether their resemblance of the lining membrane. The plaits, before they are unravelled, look like masses of tortuous vessels, lying loose and unconnected in the bottom of the ventricles.

The largest portion of each plexus choroides comes up from the posterior prolongation of the lateral ventricles ; they then run forwards. In each ventricle they lie in the groove, betwixt the thalamus nervi optici and corpus streatum ; and cover the tenia semicircularis geminum. These two plexus of the lateral ventricles unite under the anterior crus of the fornix,

and form a small plexus, which is continued upon the inferior surface of the velum interpositum, and even into the third ventricle. Again, there is a plexus which lies in the fourth ventricle. Vicq d'Azyr also describes, as occasionally occurring, little insulated plexus attached to the veins, branching on the corpora streata*. Thus each division of the brain has its choroid plexus.

These vascular webs must have an important use. I should conceive that they chiefly secreted the fluids of the ventricle; for I believe the tortuosity to be the most unequivocal mark of the activity of its vessels. This opinion, however, is nothing new†. Another prevailing idea was, that the blood accumulated in these convoluted vessels occasioned such a gentle continued heat as favoured the circulation of the spirits through the cavities of the brain, and preserved the fluidity of the water of the ventricle‡. Great variety of opinions have prevailed regarding the structure of those bodies. We see them consisting of knots of convoluted vessels; chiefly veins; or these at least are most evident from their size, and the colour of their blood. These convolutions of vessels are by many good anatomists described as glands. Varolius, Sylvius, Wharthon, Willis, Santorini, and Lieutaud, consider them as such§. Three sets of ARTERIES pass up to the PLEXUS CHOROIDES, from the base betwixt the crura of the brain; they come, 1st, from the curve of the internal carotid artery; 2d, from the communication betwixt the basilar and carotid artery; 3d, from the basilar artery, and most posterior part of the branch of communication. These arteries, which are small,

* "Sur le côté des ventricules latéraux, j'ai quelquefois obfervé de petits plexus choroides ifolés, que accompagnoient quelquefuns de ces rameaux des veins de Galien, que l'on voit paffer fous le tænia femicircularis, & s'etendra fur le corps ftrié." Vicq d'Azyr Memoir. l'Acad. Roy. 1781, p. 540.

† The fuppofed glands of the plexus choroides were conceived to fecrete the fluid of the ventricles. Where the plexus lies upon the pofterior crura of the fornix, it is often difeafed, having knots like glands, or, being raifed into vefícles, like hydatids. "Eas bullas humorem ventriculorum fecernere olim conjectura fuit. Verum vitio cum nafcantur vix perpetuum habitum generare idoneæ erunt." Haller, tom iv. 48.

‡ See Duverney, tom i. p. 55. "Ut enim fanguis intra finuum cavitates aggeftus, Balnei calidioris vicem preftat, quo spiritus animales in extima & corticali cerebri parte uberius diftillentur: ita fanguis intra plexus hujus vafa exilia contentus, quo iidem fpiritus in penitiori ac medullari fubftantia idonce circulentur, Balnei minoris, & magis temperati loco effe videtur." Willis Cerebri Anat. p. 47.

§ Galen gives a good defcription of the choroid plexus; he defcribes the innumerable veins of which it is compofed, and their joining the fourth finus by the vein which retains his name. Some have confufed themfelves with a paffage of Ruyfch. Thes. iii. No. lxv. &c. in which he is fpeaking of the choroid plexus, where it appears in the bafe of the fcull, from the bottom of the fourth ventricle. They have underftood him to fay, that the plexus was covered not with the pia mater, but with the tunica arachnoides.

are convoluted into great minuteness* in the membrane, and their blood is returned by veins, which taking a very tortuous course, seem to entangle their branches, and form a mesh of veins.

The blood of the two plexus of the lateral ventricles, and that of the third, is conveyed into the velum interpositum, or that membrane which stretches under the fornix, and over the third ventricle. The branches of veins also which extend themselves upon the sides of the lateral ventricles, and into the processus digitalis, being gathered together upon this membrane, open into the vena galeni, or rather form it.

The most remarkable branches of veins in the lateral ventricle are these: a considerable branch is seen to collect its branches upon the anterior part of the ventricle, and in the anterior sinus, or horn of the ventricle. This vein runs back towards the anterior crus of the fornix, and dips under it, just above the communication of the ventricles; and joins the veins in the velum of Haller. Other small veins are seen collecting their branches upon the corpora striata; and passing under the centrum semicirculare geminum, connect themselves with the plexus. Again several branches of veins are extended in the posterior part of the ventricle. These are from the medullary substance of the posterior lobe of the cerebrum. They pass under the posterior crus of the fornix and join the vena galeni. Lastly a vein remarkably tortuous, frequently full of blood, passes forward and is seen at intervals in the plexus choroides. This vein taking an acute turn, joins its fellow under the anterior crura of the fornix and is reflected backwards and under the fornix, so as to form the beginning of the vena galeni.

The VENA GALENI then is the great central vein of the brain. It stretches from the extremity of the fourth sinus into the internal part of the brain, to receive the blood from the membrane lining the ventricles,—from the substance of the brain,—from the plexus choroides,—and from the velum interpositum.† It lies under the posterior part of the corpus callosum, under the fornix and above the nates and testes. It is entangled in the velum itself. It consists of two great branches which lie parallel to each other, and which sometimes have the

* "Huncce plexum nil eſſe niſi arteriolas, ad viſum ſuccoſas, a naturali conſtitutione arterioſa non nihil recedentes, mirumque in modum contortas, ſerpentinoque modo reptantes, glandulaſque repreſentantes." Ruyſch, Thes. v. Aſſer. quartus No. lxviii. Not. 2.

† The velum lying upon the nates and teſtes, and adhering to them and the pineal gland, the vena galeni receives here alſo veins from thoſe bodies, and from the upper part of the cerebellum.

appearance of being twisted, and these unite before they enter the fourth or straight sinus.

In the BASIS of the BRAIN the veins are not remarkable nor do they require any description distinct from the sinuses into which they open.

They are small, having little way to run; and before they become large trunks, they empty themselves into the numerous lesser sinuses betwixt the dura mater and base of the scull.— This is perhaps a provision against the pressure of the brain. In passing into those sinuses, the veins take a long oblique course betwixt the lamellæ of the dura mater; which has given occasion to anatomists to describe many intricate lesser sinuses.

OF THE PARTICULAR SINUSES.

Although by the term sinus we are to understand the great veins of the brain, yet as having some circumstances peculiar to them, it is well to distinguish them by a distinct appellation.

SUPERIOR LONGITUDINAL SINUS.

This is a triangular channel, running in the falx from the crista galli of the æthmoid bone to the crucial ridge of the occipital bone. It is not constant in its origin. Sometimes it begins from a blind foramen before the crista galli.* Sometimes from the orbital sinus.† In some subjects it begins only opposite to the fontanelle, or even further back, and then at once swells out to a large size.

As the sinus passes backwards it is gradually enlarging for the reception of the veins from the surface of the cerebrum.— As we have already demonstrated by the marginal plate of the section of the longitudinal sinus (page 12,) the base of the angle is curved, answering to a sulcus, which runs in all the length of the cranium, from the æthmoid bone to the crucial ridge of

* Malacarne, Haller, Gautier.

† Théſe ſinuſes as frequently are continued into the inferior longitudinal ſinus or into the circular or elliptical ſinus; they are like azure ſtreaks under the dura mater, covering the orbital proceſs. " Molti fra i voti biſlunghi, ovali, tondi, irregulari, che ſi vidono all', angolo inferior del ſono L. S. Sono caverne cieche o le une colle altre communicanti laſciate dai gia deſcritti faſci della fibroſa, ſenza che ad eſſe giunga vaſo aliuno." Malacarne, p. 94.

" Hæ cellulæ ab expoſito ſinu ad verticem uſque, uberiores, atque magis amplæ perſpiciuntur, et inequaliter hinc inde locantur; ipſarum plurimæ vacuæ ſunt habentque orificia in oppoſitas quaſi partes hiantia; membrania circumteguntur quæ eſt inſtar valvulæ ſemilunaris, totam tamen cavitatem non occludentis; reliquæ vero faveolas tantummodo impervias repreſentant." Pacchioni, p. 124.

the occipital bone. The lateral planes are drawn tense and converge into an acute point; the angle formed by the splitting of the internal layers of the dura mater, is strengthened by strong slips of fibres, which upon the inside of the sinus have the effect of making it irregular, and in some degree having the appearance of cells, into some of which cells the probe enters, and leads to the veins on the surface of the brain; others are blind, or lead to lesser sinuses, which not unfrequently run parallel for some length to the great sinus; or the probe passes from one of these cells to another. Sometimes, however, the sinus has no such irregularities, but is straight and smooth through its whole length.*

This sinus has in some rare instances been found of a square shape; its lower surface serving as a roof for another sinus of a triangular form, which, for some way, runs parallel with the great sinus, and which was of course also included in the lamina of the falx—these Malacarne calls seni subalterni. Irregular lesser sinuses are by no means uncommon, and they form, sometimes, communications through a great extent of the longitudinal sinus; or again it will be found that the longitudinal sinus deviates considerably, in some subjects, from the straight line, taking a curve or circle, generally behind the fontanelle; or it sends off branches, which again unite with it; or it is fairly divided. In all these cases the chords or fasciculi of the dura mater stretch out over the sinuses, and protect them from compression.

Instead of reaching backwards to the crucial line upon the occipital bone, the longitudinal sinus has been found to divide at the beginning of the lambdoidal suture, and to follow them in a direction towards the petrous bone† while the lateral sinuses, running in the duplicature of the tentorium, were reduced to a very narrow compass.

From the strength of the connections of the sinuses, and from the languid course of the blood through them, I scarcely believe that the sinus has ever suffered the distention, which Malacarne describes in some cases. I should rather suppose that what he mentions had been natural and congenital enlargements; especially considering that the sinuses, like the other veins of the body, are very apt to be irregular.

* The internal membrane of the ſinus is perfectly ſmooth, and is continued into the coats of the internal jugular veins; it is of the ſame nature with the internal coat of the vein.

† Malacarne, part i. 148.

LATERAL SINUSES, OR THE FIRST AND SECOND OF THE ANCIENTS.

The lateral sinuses are formed by the splitting of the lamina of the tentorium, as the longitudinal sinus is by that of the falx. From the crucial ridge of the occipital bone they stretch nearly horizontally; following the connections of the tentorium in a direction toward the petrous bone; then they take a curve downwards and forward, to terminate in the internal jugular vein; passing through the foramen lacerum of the temporal and occipital bones.

Very frequently the one lateral sinus is larger than the other, generally the right is the larger, and sometimes the left is entirely wanting.*

They diverge from the termination of the superior longitudinal sinus at the crucial point of the occipital bone: but sometimes they are irregular, diverging higher, and even passing round in the circle of the posterior part of the cranium, at some distance from the tentorium.†

The right lateral sinus for the most part begins higher than the left. It is generally longer, and may be considered as the continuation of the longitudinal sinus. Nay, in some subjects, the right or left lateral sinus begins from the longitudinal one, while that of the other side is continued from the fourth, or the torcular hierophili; and the lateral sinuses are separated at their origin by a membraneous isthmus—if it should happen that the left lateral sinus receives the superior longitudinal one, it would be found to be four times the size of the right; sometimes, also, the longitudinal sinus, turning to the right, is continued into the sinus of that side; and the left lateral sinus opens or begins by two or more irregular holes.‡

I have seen a more remarkable variety of the lateral sinuses. The blood which should flow from all those parts of the brain from which the superior and inferior longitudinal sinus, and the vena Galeni, and fourth sinus are derived, seemed, instead of passing by the root of the tentorium, to have forsaken these channels; the lateral sinuses were left diminutive: and the blood had taken a course in the tract of the posterior occipital sinuses, and, after incircling the foramen magnum, it gained its usual outlet.§

* Lieutaud Anat. Hist.

† Malacarne.

‡ See Morgagni Adversaria VI. tab. i. fig. 1.

§ There are instances of the lateral sinuses opening into the external jugular vein.

The angles of the lateral sinuses are strengthened by membraneous fasciculi; which pass radiated from point to point, or are confusedly intricated; betwixt these the veins enter as in the longitudinal sinus; where the sinus descends from the level of the tentorium in the angle formed by the occipital and petrous bones, there are many strong irregular fasciculi of fibres: under this point, being no longer protected from compression, by their triangular shape and the tension of the tentorium, the sinuses are irregular; they are now sunk in the sulci of the bones, and the dura mater spreads its sheath over them.

The great irregular cavity,* in which the extremities of the lateral sinuses lie,† and the foramen lacerum, have much variety, and their straightness seems to affect the size of the sinus in its whole length.‡

OF THE INFERIOR LONGITUDINAL SINUS.

The inferior longitudinal sinus, or simply the lesser, or inferior sinus of the falx, runs in that edge of the falx which penetrates betwixt the hemispheres of the cerebrum. It is extremely small towards the fore part of the falx; but, as it passes backwards, it goes on increasing by the accession of veins which come from the hemispheres, and corpus callosum, and from the falx itself. It is formed betwixt the lamina of the falx. Sometimes it runs in its very edge, but as frequently a little way removed from it; sometimes it is found beginning very far back in the falx. The fore part of it is more like a vein running in the falx than a sinus. It is in general to be seen more superficial, and in every respect like a vein, (there being no provision for preserving it from compression) upon one side of the falx. It very often takes a waving course upon the falx; while it receives veins, which branch in the substance of the falx, and form communications betwixt it and the superior longitudinal sinus. It opens into the straight or internal sinus, near the edge of the tentorium.

* Lower conceives that the ſize of the jugular foſſa was the effect of the reflux of the blood; and that the greater ſize of the ſinus of the right ſide was to be traced to the practice of nurſes laying their children chiefly on the right ſide! See alſo Morgagni Adverſaria Anat.

† See Willis Anatom. Cereb. Hum. p. 29, and the plate.

‡ Some very large veins open into the lateral ſinus; they are derived from the poſterior lobes of the cerebrum and the cerebellum. Theſe inſinuating irregularly betwixt the lamina of the tentorium, and running for ſome way, have been conſidered as additional ſinuſes. See Haller, tom. iv. p. 149.

OF THE INTERNAL, STRAIGHT, OR FOURTH SINUS.*

I would call this the internal sinus, from its situation, but more particularly from its receiving the veins from the internal part of the brain. This sinus is formed chiefly by the vena galeni; which, coming out from betwixt the corpus callosum and tuberculi quadrigemini, enters betwixt the lamina of the middle part of the tentorium, where it is united to the falx; so that by the tension of these two partitions this sinus is drawn into a triangular form, and is as incompressible as those sinuses which run connected with the bone.

It opens, for the most part, by an oval mouth, formed by strong pillars of fibres, into the left lateral sinus, rather than directly in the middle of the communication of the three great sinuses. We shall find this like the other sinuses suffering considerable variety; or irregular smaller sinuses will often be found running betwixt the lamina of the tentorium.

POSTERIOR OCCIPITAL SINUSES.

These are so called in opposition to some irregular and small sinuses, which run upon the occipital bone before the great foramen. THE POSTERIOR OCCIPITAL SINUS lies in the little falx of the cerebellum; it rises upwards, and opens into the common union of the longitudinal and lateral sinuses; it commonly, however, lies rather to the left, and empties itself into the left lateral sinus. It is by no means † constant: like the other lesser sinuses it is subject to great variety; and, before it rises into the tentorium, or empties itself into the larger sinuses, it has a communication or emissarium, by which part of the blood may pass into the external veins, through a foramen in the centre of the occipital bone.‡

THE INFERIOR LATERAL SINUSES.

The inferior lateral sinuses are still more rarely to be found than the last, in so much that Vicq d'Azyr says he never has

* Sinus quartus, Perpendicularis. Haller—The fourth ſinus; the two lateral being the firſt and ſecond, and the longitudinal being the third ſinus.

† Vicq d'Azyr.

‡ Malacarne.—This ſinus is ſometimes double; or it has two branches encircling the poſterior margin of the occipital hole; or, as I have already obſerved, it takes the office of the great ſuperior lateral ſinuſes, and empties it into the foramina lacera; or they communicate with the vertebral veins. See Obſervations ſur un dilatation ſingulière des ſinus occipitaux, Mem. de l'Acad. Roy. Anno 1781, p. 596.

seen them. They run in the lamina, or under the dura mater, of the posterior fossa of the base of the scull; that is the hollow of the occipital bone, which is under the tentorium. They are so irregular that they frequently occur in one or other side only. They communicate with the posterior part of the foramen lacerum; with the posterior petrous sinus or vertebral veins; or lastly they occur as an irregular collection of channels running in the several neighbouring sinuosities.*

We see then that there is a point of union for all these sinuses, which we have not as yet described: we see that the superior longitudinal sinus, the two lateral sinuses, the fourth (and consequently the inferior longitudinal sinus,) and the posterior occipital sinus, unite at the crucial spine of the occipital bone. This is the torcular hierophili,† torcular, lacuna, platea, tertia vena, palmentum, pelvis, laguncula. It was natural that the attention of the ancients should be drawn to this part; for, upon opening this union of the sinuses, we find a large irregular cavity, which seems to be particularly strengthened by these strong fasciculi of fibres, which form the support of the sinuses.‡ Ignorant of the circulation, imagining that the blood ascended by the great jugular veins to the lateral sinus, and seeing that the lateral sinuses opened into this central cavity, they conceived that the blood destined for the brain underwent an operation there, and was thence sent through every part of the brain.§

* "Independente dai feni lateralia inferiori ho veduta tra le robufte lamine e le fibre, dalle quali incomincia craffiffimo l'imbuto vertebrale intorno al maggior foro del cranio una quantita di caverne, di cellule communicanti infieme, le quali formavano un feno circolare irregolariffimo appoggiato fulla parte fuperiore, o fia ful margine interno del foro medefimo." Malacarne, p. 113, 114.

† Herophilus was a Greek phyfician, and difciple of Praxagoras, and cotemporary with Erafiftratus.

‡ "Deinde et illia per fectionem fcalpellum injiciens, furfum adigere conoberis ad ufque verticem ubi venæ duæ invicem congrediuntur; quam regionem Herophilus nominat lenon, torcular Galen. Lib. Nonus de Cerebri, &c. Diffectione."

§ "Coeuntes autem in vertice capitis, quæ fanguinem deducunt meningis duplicaturæ, in locum quendam vacuum quafi cifternam (quem fane ob id ipfum Herophilus torcular folet nominare,) inde velut ab arce quadam omnibus fubjectis partibus rivos mittunt; quorum numerum nemo facile dixerit, quod partium nutriendarum numerus fit infinitus. Manant autem rivorum nonnulli quidem ex medio ipfo loco in totum cerebellum, fecti, ac derivati, eodem prorfus modo, quo ii qui in areolis, alii autem ex parte anteriore feruntur, ea fcilicet qua torcular excipit dixeris utique velut rivum quendam fanguinis, quem et ipfum ex craffa meninge admodum ingeniofe fabricata eft, partibus enim ipfius meningis quæ fanguinem duxerunt ad torcular appulfis, dimiffaque illinc aliqua in partes fubjectas, non amplius, quod fuperarat, uni venæ concredidit, fed preterea ex craffæ meningis partibus anterioribus extenfis rivulum efficit, ex quo primum multos rivulos per totam viam produxit." Galen, cap. vi. *de torcular. Et quo pacto venæ intra cerebrum diftribuantur.*

OF THE LESSER SINUSES IN THE BASE OF THE SCULL.

Besides those larger sinuses which we have described, and which convey back the great proportion of blood circulating in the brain, there is a set of lesser sinuses which lurk betwixt the dura mater and the anterior part of the base of the scull. These last are fully more intricate than the others; they lie upon the irregular surface of the sphenoid, temporal, and occipital bones; and tend backwards to the great embouchoir formed by the irregular hole in the temporal and occipital bones.

THE SPHENOIDAL SINUSES.

The SUPERIOR SPHENOIDAL SINUSES are seated in a fold of the dura mater, on the internal margin of the wing of Ingrassias, and before the great wing of the sphenoid bone; they receive the blood in part from the orbit, and from the dura mater; they open into the cavernous sinus, or perhaps into the ophthalmic sinus, which of course, for the most part, conveys the blood into the superior or inferior longitudinal sinus.

The INFERIOR SPHENOIDAL SINUS is very irregular and inconstant. It is in the dura mater, covering the great wing of the sphenoidal bone; the blood of this sinus is emptied into the cavernous sinus, or escapes by emessarii into the trunk of the temporal veins.

The ANTERIOR CLYNOID SINUS.—The posterior clynoid sinus, or elliptic sinus, and the circular sinus, are one and the same; the difference consists only in the manner of describing them; the CIRCULAR SINUS lies within the clynoid processes of the sphenoid bone, and surrounds the glandula pituitaria*.

As this circular sinus opens upon each side into the cavernous sinus, it is not unaptly divided into two; the anterior half of the circle, being the anterior clynoid sinus of some author; the posterior half (which is in general wider), the elliptical or posterior clynoid sinus, or semilunar.

* Ridley defcribes it in thefe words: "Another I difcovered by having injected the veins with wax, running round the *pituitary gland* on its upper fide, forwardly within a duplicature of the dura mater, backwardly between the dura mater and pia mater, there fomewhat loofely ftretched over the fubjacent gland itfelf, and laterally in a fort of canal made up of the dura mater above, and the carotid artery on each outfide of the gland, which, by being faftened to the dura mater, above and below, at the bafis of the fcull, leaves only a little interftice betwixt itfelf and the gland." (Accuratius tamen a Rilleyo defcriptus eft. Haller.) But Ridley is affuming merit to himfelf. Brunnerus defcribes this finus.

This sinus, like most of the lesser sinuses, is irregular in its shape, its size, its communications, and its origin*. Its natural communication is with the cavernous sinus, which in fact encroaches upon its side; it will be found to communicate also with the sphenoidal sinuses, and the obliqui or petrous sinuses†: at one time the anterior half of the circle is wanting; at another the posterior‡.

THE CAVERNOUS SINUS.

The cavernous sinus is a great irregular centre of communication with the lesser sinuses in the base of the scull. This sinus is sunk upon each side of the sella turcica, and is formed in the irregular splitting of the lamella of the dura mater: it is of a triangular shape; it extends from the sides of the sella turcica, even to the foramen spinali§. The pointed extremity of the tentorium, which extends forwards from the angle of the petrous bone to the posterior clynoid process, covers and protects it. The cavernous sinus is different from all the others; it is an irregular cavity, full of fibrous cords traversing it, which gives it a kind of cellular appearance. It is like a diseased part into which the blood had been driven, till the cellular texture had been distended and partly destroyed. After a minute injection, small arteries are seen to ramify among these fibres; the internal carotid artery rises through it, and the sixth pair of nerves is involved in it, in their passage from the scull.

This sinus is the centre of the little sinuses and veins of the anterior part of the base of the brain and cranium: four or five veins pour their blood into it, from the anterior lobes of the brain and the fossa silvii; sometimes, even the ophthalmic veins open into this receptacle‖. The superior and inferior petrous sinuses, and the basilar sinus, open into it behind; the circular before; the sphenoidal sinuses and veins of the

* "Varie ſono le origini, e le foci di queſto ſeno. Alcune volte il fondo della foſſa pituitaria vi invia due canaletti longitudinali, che ſcorrono ſul dorſo di quelle due pieghe ſottili falcate ond-iè tripartita la glandula pituitaria. Altre volte la foſſa diviſa per traverſo da una ſimil piega che pure ha ſul dorſo il ſuo ſeno, allo elittico lo invia." Malacarne, p. 123.

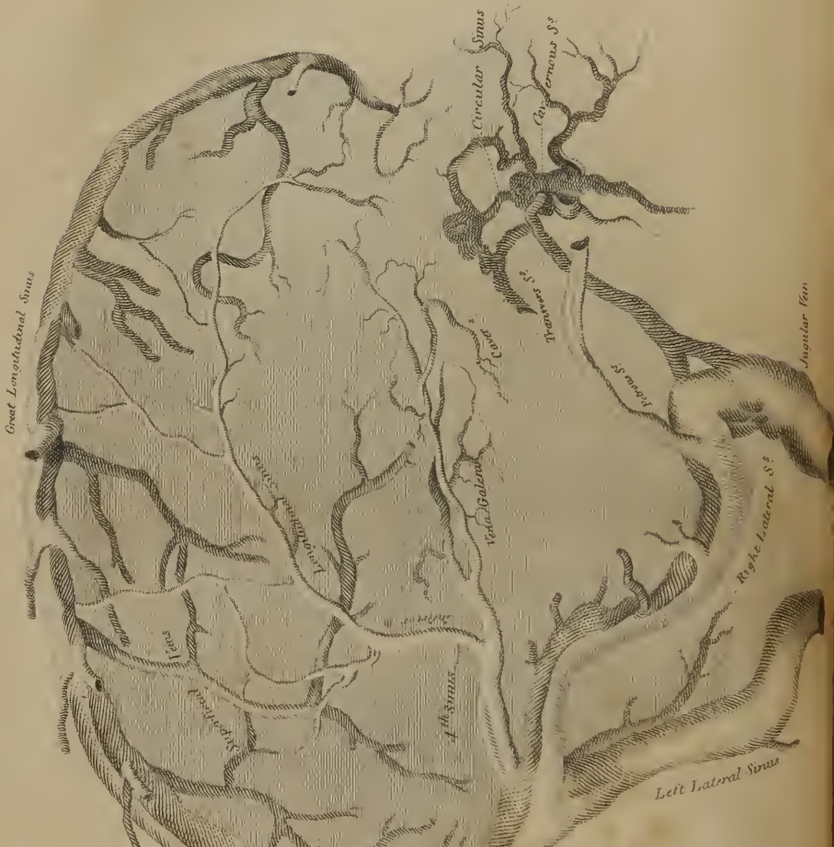
† Haller, tom. iv. p. 154.

‡ "Nunc anterior nunc poſterior ejus arcus amplior eſt; nunc anterior nunc poſterior ejus arcus deficit; nunc totus ipſi deſideratur; interdum vere duplicem fuiſſe, referunt." Sommerring, vol. v. p. 354.

§ Malacarne.

‖ This vein, the vena angolana, makes a very remarkable emiſſaria, but it is more probable that the blood in ſuch veins runs inwards than that it eſcapes from the ſcull to the external veins.—Cum venis poſterioribus frequentes nexus init. Sommerring, vol. v. p. 354.

Plan of the Sinuses



dura mater upon the side; while the right and left sinuses often communicate by means of the transverse sinus. Besides these the petrous sinuses have several communications, or emissaria as they are called, viz. by the inferior maxillary foramen, the funnel of the carotid artery, through which descends a vein, (the vena sodalis arteriæ carotidæ), which terminates in the pterygoid plexus of veins, the sphenoidal fissure, the interosseous sinus of Malacarne*.

The TRANSVERSE, OR POSTERIOR CLYNOID SINUS, runs across from one oblique sinus to another behind the posterior clynoid processes†. In its form it is not peculiar, nor is it very regular.

There are two PETROUS SINUSES, the anterior and posterior, or the inferior and superior sinuses; these two come off nearly together from the cavernous sinus, and running back upon the petrous bone, terminate in the lateral sinuses or beginning of the internal jugular vein; but which two to take as petrous sinuses is a question. For example, Malacarne shows that there is a sinus, by no means uncommon, which belongs as strictly as those others to the petrous portion of the temporal bone.

He calls this new sinus the anterior petrous sinus; and the superior of other writers, he calls the posterior petrous sinus; and the inferior petrous sinus of other writers, as it lies more upon the cuneiform apophysis of the occipital bone, and runs slantingly, he calls the oblique. I would on the contrary consider two of these as the petrous sinuses; the oblique sinuses of Malacarne, as the lateral basilar sinuses; and those which run on the middle of the cuneiform apophysis, as the middle basilar sinuses.

The ANTERIOR PETROUS SINUS runs upon the anterior face of the petrous bone, from near the spinal hole‡; whence, making a semicircular curve in the angle of the petrous and squamous portions of the temporal bone, it terminates in the lateral sinus.

The POSTERIOR PETROUS SINUS§ lies in that pointed extremity of the tentorium, which stretches forward, connected with the acute angle of the petrous bone. It is narrow; and a sulcus or groove on the angle of the bone gives a partial

* The Emiſſaria, 4ta. of Tabarini. Obſerv. Anatom. p. 42, et. ſeq

† In truth the ſuperior, and inferior, or oblique ſinus, the cavernous, and the tranſverſe, meet nearly at a point.

‡ And here it has a tranſverſe branch of communication with the cavernous ſinus, which runs under the extended point of the tentorium.

§ Or ſuperior petrous ſinus. Vicq d'Azyr.

lodgement to it ; it passes from the cavernous sinus to the great lateral sinus.

The LATERAL BASILAR SINUS* is shorter and larger than the last ; and it makes an oblique curve from the cavernous sinus under the pointed extremity of the tentorium, which is continued by the side of the sella turcica, to the termination of the lateral sinus, or rather into the beginning of the jugular vein, by a channel, separated by a bony lamina from the termination of the lateral sinus ; or it is continued into a vein in the base of the cranium, which afterwards joins the great jugular vein.

The MIDDLE BASILAR SINUS. This scarcely deserves the name of sinus. It consists, in general, of a few cellular-like communications, formed in strong fibres of the dura mater, which here partakes of the nature of a ligament. These open into the last mentioned sinus, or sometimes into the vertebral sinus.

The VERTEBRAL SINUSES are veins included in the lamellæ of the dura mater ; and, divided into right and left ; they descend into the tube of the vertebræ, on its fore part, and pass down even to the sacrum. They are connected in all their length with the vertebral, dorsal, and lumbar veins. These sinuses, or veins, at each vertebræ, are joined by a transverse branch ; they are connected at the top of the spine with the basilar or anterior occipital sinuses, and with the fossa of the jugular vein.

EMISSARIA SANTORINI.

"Venæ Emissariæ" is but another name for those lesser veins which form a communication between the sinuses within the head, and the external veins in the base of the cranium. These, then, are chiefly the ophthalmic,† mastoidean, and vertebral veins. But the vena sodalis, arteriæ carotidæ, the small vein which penetrates the parietal bone by the side of the sagittal suture, even the venæ arteriæ meningeæ sodales, and the little veins which pass with some of the nerves, or through the fissures of the bone, are also brought into account. To these a much greater importance has been attached than they merit; particularly in apoplectic affections of the head, they are sup-

* The inferior petrous, or oblique ſinus.

† "Je me ſuis convainçu, par des diſſections multipliées, que les ſinus caverneux et orbitaires communiquent, par un plus grand nombre de veinules, avec les arrières-narines, de ſorte que les hémorrhagies critiques qui ſe font par les nez, dans les fièvres aiguës, où la tête eſt affectée, s'expliquent facilement par ce moyen," &c. Vicq d'Azyr, Acad. Royale, 1781, p. 504.

posed to be eminently useful in emptying the surcharged sinuses and veins of the brain into the external veins.

But those lesser passages for the blood, supposing us to be assured that the blood flowed through them, from the sinus to the external veins, are insignificant, when compared with the great outlet of the INTERNAL JUGULAR VEIN; to which we have seen all the sinuses tend. But the accumulation of blood in the vessels of the brain is seldom mechanically produced; it is a disease in the action of the system of the brain, to which we become more and more liable as we advance in years: it is the same gradual change which is operating on the venous system from infancy to old age, that causes this class of diseases of the brain to be peculiar to advanced life.

The importance of the sinuses in the circulation of the blood in the brain, is either vaguely described, or imperfectly understood by authors. We find it said, that the sinuses support the blood against compression, and protect its free circulation. This to me seems an erroneous idea. The lesser veins are, as in other parts of the body, and have no such provision; and since, within the head, there can be no such partial compression as in the limbs, any cause which would compress the greater veins, were they not supported, must fall upon their extremities with worse effect. The circulation is the only power which can act mechanically upon the brain; but this can never cause a compression of its veins, because the increased action of the arteries must tend more to the distention of the veins than it will be the occasion of the brain compressing them.

The more general idea conceived of the use of the sinuses is nearer the truth; *viz.* to prevent the sudden and violent action of the muscles of respiration, or of the muscles of the head and neck, from repelling the blood into the vena cava, or internal jugular veins; and consequently preventing the impulse from being communicated to the blood in the small and tender veins of the brain, which might endanger a rupture of them.* Yet this is not exactly the manner in which the sinuses preserve the lesser veins; they do not suffocate nor take off the force of the impulse from the regurgitating blood, so much as they would do if they were like the trunks of veins in other parts; because, being incapable of distention, they throw the undulation of the blood, when it is thus checked in its exit, backwards upon the extremities of the veins. But then the effect is, that no particular vein or trunk receives the shock; all suffer in a lesser degree, and equally, which is their safety. All

* Monro, Nervous Syſtem, p. 4.

the veins in the base of the brain, which would be liable to rupture, or distention, from receiving, in their sudden turns, the shock of the blood, checked by the muscles of respiration, or otherwise, are preserved by being inclosed in sinuses, and covered by the strong lamellæ of the dura mater. The lesser vessels again are removed from the shock: its force is spent, because it has spread among many branches; and it has become a general impulse upon the brain, which the brain resists, because it is incompressible.

That the brain does receive such an impulse, in violent coughing and straining, is sufficiently evident from the rising of its surface on these occasions, when it is accidentally laid open by fracture, or the trepan.*

Although the obstruction of the jugular veins were to cause no regurgitation of the blood; although the sinuses were supposed to have an effect in preventing the distention of the veins, or return of the blood to the head; still one effect of the continued action of the arteries is, to increase the plethoric state of the brain, when there is a stagnation, or more or less remora, of the blood in the sinuses; and thence it is, that in every interruption to the free exit of the blood, the distention must ultimately fall upon the extreme vessels.†

We ought not to confound the idea of incompressibility of the brain with that of a solid substance, which would allow no motion in the vessels within the cranium, and would require us to invent some specious means to account for the circulation of the blood in the brain, different from that of the other viscera of the body. Were the brain thus incompressible, or rather solid, so as to prevent a free action of the vessels within the cranium, then, as the blood enters with an evident pulsation, it must necessarily have returned by the veins with a distinct pulsation; but this pulsation is lost here, as in the other vessels of the body, before it returns by the sinuses. When the blood

* The older phyſicians, obſerving the connection betwixt the motion of reſpiration and of the brain, conceived that the air was drawn through the noſe and crebriform bone into the brain, ſo as to diſtend it. Upon this hypotheſis followed many wonderful caſes.

We have already mentioned the hypotheſis which ſuppoſed compreſſion and relaxation of the cerebrum and cerebellum alternately, by the action of the falx and tentorium.

† We ſhall ſay that theſe veſſels cannot ſuffer diſtention, unleſs there be ſpace given for their inordinate dilatation, by blood proportionally ſent out from the cranium. But there is a degree of diſtention upon them, a tenſion which cannot be relieved, nor the contraction of the arteries allowed. The impulſe from the heart and arteries is ſtill continued, and is increaſing the evil. Bleeding here relieves this action, and diminiſhes the danger; and by this means we can ſuit the activity of the veſſels entering the brain, to the temporary remora in thoſe which convey the blood out of the head.

is sent into the arteries of the brain, by the stroke of the heart, they dilate ; and this dilatation the pliability of the brain allows, by throwing a comparative degree of pressure upon the veins. Again, when the arteries (during the dilatation of the heart) are in action, and contract, their blood enters the veins, so as to give to them a degree of dilatation equivalent to their former compression, and which now gives the freedom of contraction in return to the arteries ; without any compression, therefore, of the brain into a lesser space, there is an activity allowed in the vessels.

This degree of motion, communicated through the brain, is very small, nor does it affect the function of the brain ; as we see, when the scull is laid open, and the pulsations of the arteries are, as it were, accumulated, in their effect, to one point ; for here the patient does not suffer, although the brain beats so as to be sensible to the eye. The accumulation of the blood in the brain may be obstructed, or it may be accelerated, until this velocity affects the function :* or the blood may be accumulated ; but during this accumulation of the blood there must be a proportional space, freed by the absorption of the brain itself, or the partial accumulation of one part of the vascular system of the brain must necessarily be accompanied by a deficiency of the other.

* There is much found reafoning and ingenuity wafted on the fubject of the circulation of the brain : as the gentle murmuring of a ftream, fays Lower, lulls to repofe, while the mind is difturbed, or the imagination awakened by the din of a cataract ; fo fleep is induced by the gentle flow of the blood in the brain, or flies when the circulation is accelerated. As the fatigue and reft of the body required a variation in the impetus of the blood towards it, the neceffary confequence was a variation in the degree of velocity in the circulation and quantity of blood in the head, and this to Lower is the reafon of the viciffitude of wakefulnefs and fleep. The fimple fact of the effect of preffure upon the furface of the brain inducing an oppreffion of the fenfes has occafioned all their theories of fleep to turn upon this one idea of preffure on the brain.

CHAP. III.

OF THE VENTRICLES AND INTERNAL PARTS OF THE BRAIN.

OF THE CAVITIES OF THE BRAIN IN GENERAL.

THERE are within the Brain many tubercles and irregular surfaces, of which it is infinitely more difficult to convey an idea by description than of the external parts. These surfaces, as the name implies, lie in contact without adhering; and form what we call, though not perhaps with strict propriety, the cavities of the brain. Not being separated, they are scarcely to be considered as cavities, although they be capable of distention by the infiltration of the fluid into them. The surface of the cavities or ventricles of the brain is naturally bedewed with a fluid or halitus, which flows from the general surface of the ventricle, and from the plexus choroides. This moisture preserves those surfaces from adhesion; during life and health it is not accumulated so as to form a fluid; but in many diseases, and after death, it is effused or collected into a fluid. The external convolutions of the brain we have seen to be cineritious on the surfaces: the internal surface of the brain may be considered also as forming convolutions; but they are chiefly medullary, and are more irregular, or rather have a greater variety of shape, than those of the outer surface.

In regard to the use of the ventricles of the brain, since the hypotheses of the older physicians have been tacitly rejected, no opinion has been offered, except this, that "they seem to be made of a necessary consequence, and towards the greater use and distinction of parts;" or, as we have already had occasion to mention, that the ventricles serve to increase the surface of the pia mater, and that whatever may be the purposes which are served by that membrane on the surface of the brain, we must suppose the same to be performed by it within the ventricles. But this is a conclusion which may not be altogether satisfactory to an inquisitive mind.

It is necessary to take into consideration the general peculiarities of the brain: we find that within the scull there is no

adipose substance, though it pervades every other part of the body. We at once see a reason for this. It is evident that as the fat is so incessantly undergoing changes (being alternately absorbed and deposited); as at one time it is deposited in greater quantities and at another absorbed; as it is in perpetual variation according to the prevailing habits of the body, the proportion of exercise taken, or the state of the health; its continual changes would have the very worst consequence upon such a part as the brain; that if accumulated it would oppress the circulating vessels; if rapidly absorbed it would be followed by accumulation or surcharge of the vessels; for the scull does not allow of distention, nor is it possible that it can admit of depletion.

I conceive the ventricles to be a provision for allowing those changes to take place, which necessarily, from time to time, arise, or are occasioned by disease in the substance of the brain itself: they prevent an instantaneous bad effect. When fluids distend the ventricles, it sometimes occurs to us that the fluid, secreted and accumulated, must have compressed the substance of the brain, and caused its absorption; but I conceive that frequently the cause is reversed; the absorption of the mass of the brain being the disease or its consequence, and the fluid being poured out in the ventricles to supply this deficiency: I also conceive that the collected fluid being in the central parts, is a particular provision by which the whole mass of the brain is kept uniformly distended; whereas, if the surface had been equally, or more disposed to such secretion of fluid, the internal parts would have fallen flaccid, and been compressed rather than supported.

There cannot be a more erroneous notion than that in Hydrocephalus the compression produced by the secreted fluid occasions the wasting of the brain. In that disease the substance of the brain is not firm and compressed, so as to prevent the veins from being completely filled; but, even in a very early stage, the mass of the brain is soft and fluid; the veins peculiarly distended or enlarged; and from the first or inflammatory stage of the acute hydrocephalus, or the permanent state of the chronic, the disease is not a dropsy of the ventricles, but a universal affection of the brain. The effect of the disease is, that there is a change in the relative powers which incessantly secrete and absorb the brain itself, as every other part of the body is secreted and absorbed. And in consequence of this there is a diminution of the solids of the brain, and an accumulation of the fluids to supply their loss.

It is not to be supposed that the ancients, so fertile in their hypotheses, and so easy in their proofs, could neglect the

evident importance of the ventricles of the brain. We accordingly find that the spirits were manufactured in these cavities; that they were the "spirituum animalium officina," whence the spirits were conveyed over all the nervous system*. They were again degraded from this higher office, and became the mere receptacles of the excrementitious matter of the brain (meras cloacas esse asseruerint†); and Willis seems inclined still further to degrade the importance of the ventricles, by considering them merely as of secondary importance; or rather as resulting solely from the accidental conformation of the brain‡. Again we find it a prevalent opinion that the ventricles contained air; that the air supported the soft medullary substance of the brain; and that it gave motion to the whole mass, so as to circulate the spirits in the substance of the brain§.

OF THE CORPUS CALLOSUM AND CENTRUM OVALE OF VIEUSSENS.

THE CORPUS CALLOSUM is a medullary body which is a centre of communication; or it is the great commissure|| passing betwixt the hemispheres of the cerebrum¶: it is seen without incision by merely separating those hemispheres with the fingers. It is a white body, firmer than the rest of the medullary substance. It is but slightly convex upon its upper part, but turns convex downwards upon the fore and back part. As the corpus callosum is the continuation of the internal medullary

* Lately, by chemical aids, (which make the cineritious fubftance black, or dark brown, while the medullary matter remains white, or takes a flight greenifh tinge,) the origins of many of the nerves have been traced into the fubftance of the brain, even to the furface of the ventricles, which has given occafion to the revival of fimilar ideas of the ufe of the ventricles.

† Willis Cereb. Anat. p. 32.

‡ "Porro fi quis cerebelli fabricam exacto confiderat, et ferio perpendit, quod hi ventriculi non ex primaria naturæ intentione efformentur, at fecundario tantum et accidentaliter de cerebri complicatione refultent," &c.

§ Malpighi.

|| Commiffure is a term applied to thofe tracts generally of medullary matter, which paffing through the brain are fuppofed to be a medium of communication.

¶ Willis conceiving the fpirits to lodge and circulate in the fuperficial convolutions of the brain, (upon the conformation of which depended the capacity or ability,) gives to the corpus callofum the property of collecting and concentrating the fpirits, "quafi in *publico emporio* commorantur;" and here they were depurated by repeated circulation.—But the language in which all this is delivered better veils the abfurdities of the doctrine: "fpiritus recens nati undequaque ab extima hujus corporis ora verfus anteriorem iftius corporis callofi partem, ubi craffimum exiftit, perpetim blande fcatent; ibidemque, fi opus fuerit, aut imaginationis actui impenduntur, aut medullæ oblongatæ crura fubeuntes, appendicem nervofam actuant et infpirant." What remains fuperfluous of the fpirits returns backwards and circulates through the fornix, and is ftill farther fubtilized, "hoc motu fubtiliores quofdam phantafiæ actus peragunt."

substance of the brain, it is superfluous to say that it is continued down, anteriorly, into the medullary matter betwixt the corpora striata, terminating in its pedunculi ; or, backwards, that it is continued with the fornix and cornua ammonis and the surface of the posterior prolongation of the lateral ventricle.

We see upon the surface of the corpus callosum two medullary lines considerably raised, running parallel to each other* in the length of the body. Betwixt these salient lines there is of course a kind of rut, called sometimes the rapha, or suture, which may be considered as dividing this body into two equal parts, and which, in truth, forms the accurate division of the two sides of the whole brain.†

Other lines, less elevated from the surface, are to be observed running across these, as if passing from one hemisphere to the other. If the corpus callosum be cut horizontally, and the section be continued into the substance of the hemispheres, we still can perceive those transverse lines, and observe them to be lost in the medullary matter of the hemispheres.‡

THE CENTRUM OVALE is merely the appearance which the white and internal part of the cerebrum takes when the brain is cut horizontally on the level of the corpus callosum ; for then the corpus callosum is the centre of the great medullary mass of the cerebrum, and the external cineritious matter being on the edges only forms it into an irregular oval.

THE SEPTUM LUCIDUM.

THE two lateral ventricles lying under the corpus callosum and medullary centre are divided by a partition, which descends from the lower surface of the corpus callosum, and rests upon the fornix. This septum of the ventricles is transparent, and consists of two lamina, and these consist of medullary and cineritious matter.§ Betwixt these is the cavity of the sep-

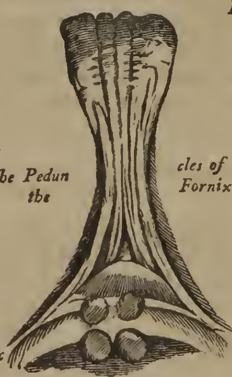
* They are not ſtrictly parallel in all their length ; we find them often ſeparated both upon the fore and back part ; but generally more ſeparated upon the back part, and even ſometimes they are curved.

† In which conceit Duverney calls this " clef du cerveau," from its being the centre of communication. Tom. i. p. 39.

‡ The neceſſity of explaining paralyſis and convulſive motions of that ſide of the body oppoſite to the ſide of the brain injured, has made anatomiſts attend to thoſe tranſverſe lines, in the hopes of finding ſuch a decuſſation of theſe lines as would account for it. Sabbatier ſays, they have brought themſelves to believe that there was a decuſſation, but after careful inveſtigation he could find no ſuch thing. See Winſlow. Ludwig (de Cinerea Cerebri, ſub. p. 5.) obſerved ſtriæ of cineritious ſubſtance in the corpus calloſum. See alſo Gunz. and Haller.

§ Vicq d'Azyr.

tum lucidum.* The size and shape of this cavity differ in a variety of subjects. It is of a triangular shape, and from eighteen to twenty lines in length.† It has a fluid exhaling into it like the ventricles, and is by some counted as a fifth ventricle: according to Santorini it opens in the base of the brain, opposite to the union of the optic nerves. Vieussens describes it communicating with the third ventricle.‡ Winslow also has seen it reaching a great way backwards, and conceives it to open into the third ventricle. Soemmerring describes it as large in the middle, contracted backwards, and having no communication; but he asserts that it is shut in on every side.§ In the base of the brain we find a narrow longitudinal sulcus betwixt the pedunculi of the corpus callosum. In the bottom of this cavity there is a medullary lamina, which Vicq d'Azyr calls "*Cloison à la cavité du septum lucidum.*" And the sulcus he calls "*Fosse de la base du* SEPTUM LUCIDUM." By a careful section of this medullary substance we lay open the cavity of the septum lucidum.



LATERAL VENTRICLES.

UNDER the corpus callosum and medullary centre, are the lateral ventricles. They are distinguished into right and left.

* It was discovered by Silvius. See also Santorini.

† Sabbatier.

‡ "In qua pellucidam non raro reperimus aquamque haud dubie in tertium illabitum ventriculum." Vieussens de Cerebro, p. 59.

§ De Corporis Humani Fabrica, tom. iv. p. 55.

They are of a very irregular shape, stretching into three prolongations or cornua, whence they have the name of tricornes. They are the great ventricles of the brain ; the third and fourth being comparatively very small. What may be considered as the bodies of these ventricles are formed betwixt the corpus callosum and medulla of the brain, and the convexity of the corpora striata and thalami nervorum opticorum. Following the cavity forwards, we find what is called its ANTERIOR HORN or sinus, formed betwixt the more acute convexity of the corpus striatum and the anterior part of the corpus callosum ; into the posterior lobe of the cerebrum, resting upon the tentorium, there stretches backwards with some considerable curve, and, at the same time, with a slight inclination downwards, the POSTERIOR HORN.

Again, the INFERIOR OR DESCENDING HORN is like the continued cavity of the ventricle ; it takes a curve backwards and outwards, and then turning forwards it descends into the middle lobe of the brain.

The lateral ventricles do not terminate in the others by any of those prolongations ; but they communicate, upon a very high level, with the third ventricle and with each other, by a wide opening, formed under the fore part of the arch of the fornix. This communication we easily find by following the choroid plexus forward and under the fornix: it is a space betwixt the most anterior part of the convexity of the optic thalami and the anterior crura of the fornix.

OF THE PARTS SEEN IN THE LATERAL VENTRICLES.

THE FORNIX is a medullary body, flat, and of a triangular shape, which divides the two lateral and the third ventricles : its lower surface is towards the third ventricle : its lateral margins are in the lateral ventricle. On its upper surface it supports the septum lucidum, or partition of the two lateral ventricles, and under its most anterior part is the communication betwixt the lateral ventricles and the third ventricle.* One of the angles is forward, and the other two towards the back part : it rests chiefly upon the thalami nervorum opticorum, but it is separated from them by a vascular membrane, which is continued from the external pia mater, and which stretches into the brain betwixt the posterior part of the corpus callosum and tubercula quadrigemina, and which membrane connects the plexus of the lateral ventricle. The fornix leaves betwixt it and

* Of this communication fee farther in the Anatomy of the Brain illuftrated by Engravings.

the concave face of the most anterior part of the corpora striata, a triangular space, which is in part occupied by the septum lucidum.

The extremities of this body are called crura. The posterior crura coalescing with the corpus callosum, (which is continued downwards posteriorly,) are prolonged into the hippocampi, and the anterior crura forming the anterior angle being close together, bend downwards behind the anterior commissure, and are connected with it: they then bend round the thalami, and may be traced into the crura cerebri; or, according to others, they form the corpora albicantia.* Those pillars or crura of the fornix are fibrous in some slight degree like a nerve. This is to be observed by cutting them either across or in their length.†

Upon the lower surface of the fornix there are lines like those of the corpus callosum, and which are erroneously conceived by many to be the impression of the vessels of the velum. It is this lower surface of the fornix which is called LYRA, CORPUS PSALLOIDES, it being compared to a stringed instrument.‡

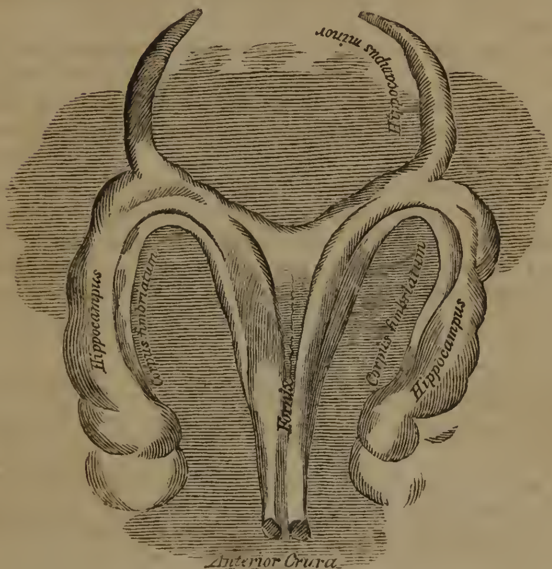
* Two white bodies feen on the bafe of the brain behind the infundibulum.

† Vicq d'Azyr, Acad. Scien. 1781, p. 517.

‡ The prevalent idea amongft the older authors regarding the ufe of the fornix was, that it acted like a ligament binding together the internal parts of the brain; or that it fupported the incumbent weight of the upper parts of the brain from preffing upon the lower. "Verum alter atque ifte infignior fornicis ufus effe videtur q.em modo invenimus; nempe ut fpiritus animales per ejus ductum ab altera cerebri extremitate ad alteram immediate tranfeant, atque ita quafi per pelicani roftrum in fui ipfius ventrem intortum circulentur." Willis.

OF THE HIPPOCAMPI, OR CORNUA AMMONIS, AND OF THE TENIA HIPPOCAMPI.

Plan of the Connections of the Fornix with the Hippocampus, &c.



THOSE parts are to be seen continued from the posterior crura of the fornix. We have observed, that upon the back part, the fornix adheres to, or is continuous with, the corpus callosum. We shall find also that its posterior crus on each side divides into two lamina of medullary matter: the one of these is continued into the cornu ammonis, and the other (being the anterior of these portions) forms the tenia hippocampi.

The hippocampus is narrow at its commencement in the posterior crus of the fornix*; but it is enlarged as it descends,

* In ſpeaking of the origin of the hippocampus as from the fornix, I mean ſimply that the ſtudent having gained the knowledge of one part of the brain may trace the others from their relation to it, and that, underſtanding the ſituation and relation of the fornix, he traces its crura until he finds them terminating in the hippocampus. We might fully as well ſay that the hippocampi are formed from the poſterior part of the corpus calloſum, for they are the ſame medullary matter continued.

following the course of the inferior prolongation of the lateral ventricle towards the base of the brain. It is, indeed, merely a relief or particular convexity of the floor of this lower horn of the ventricle, like a pad. The inferior extremities of the hippocampi on each side turn inwards, pointing to the crura cerebri, and taking thus a curve like a ram's horn*. In its whole extent the hippocampus consists of an internal cineritious substance, and a superficial layer of white medullary matter†.

The TENIA HIPPOCAMPI, or CORPUS FIMBRIATUM, is the prolonged margin of the fornix: it is merely the thin edge of the hippocampus, which follows in the whole of its circuit, and terminates in an acute point near its bulbous extremity.

The LESSER HIPPOCAMPUS, or COLLICULUS, is a relief or convexity in the floor of the posterior horn of the ventricles, which may be traced backwards from the crura of the fornix. It has the same relation to the fornix which the greater hippocampus has, and lies in the posterior horn or prolongation of the ventricle into the posterior lobe of the brain, in the same way in which the great hippocampus lies in the inferior horn or prolongation of the ventricle into the middle lobe of the brain.

The velum and plexus require to be taken away before we can fully understand the situation of the third ventricle, or of those tubercles which are but partially seen in the lateral ventricles.

The VELUM lies in the centre of the brain, and extends from the surface of the brain inwards betwixt the posterior lobes of the cerebrum and the cerebellum, then betwixt the corpus callosum and nates and testes, and then under the fornix. It forms thus a great communication betwixt the external and internal membranes of the brain. As it lies under the fornix, that medullary lamina adheres to it, while the velum again adheres to the thalami nervorum opticorum. Its margin seems to be terminated laterally by the choroid plexus (when we view it after raising the fornix); but it is not strictly so, for the choroid plexus is continued with the membrane of the ventricles, and has no where a termination. For the vascularity of this membrane, turn to what has already been said in speaking of the internal veins of the brain.

* Betwixt the extreme point of the hippocampi and the crura cerebri (when the baſe of the brain is turned up) we can inſinuate the probe into the inferior horn of the lateral ventricle without piercing the ſubſtance of the brain, but merely tearing the pia mater.

† " Vers la partie inferieure et poſterieure du corps calleux, on trouve, de chaque côté, un petit bourrelet de ſubſtance griſe qui ſe prolonge dans l'epaiſſeur de l'hypocampe dont il fait partie: ce bourrelet eſt recouvert dans ſon principe par une lame de ſubſtance blanche." Vicq d'Azyr, loc. cit.

Seeing how the plexus choroides are formed and connected, they cannot be strictly said to have either beginning or termination; they are the connected folds and plicæ of the internal membrane of the ventricles loaded with vessels; but to describe them intelligibly we must, notwithstanding, trace them in this manner. The PLEXUS of the LATERAL VENTRICLES rise from the bottom of the inferior horns of these ventricles betwixt the pedunculi or crura cerebri and the termination of the hippocampi; they lie large and fleshy-like in that lower horn. As they rise into the superior level, they are at their greatest size (there they have often a diseased appearance, being hard, and as if schirrous or full of little vesicles or hydatids); they then pass forwards and inwards, diminishing in thickness until they coalesce under the fornix, and immediately behind the communication betwixt the ventricles. The PLEXUS OF THE THIRD ventricle, formed by the union of those of the lateral ventricles, turns back upon the lower surface of the velum, and is comparatively very small.

The CORPORA STRIATA are smooth, cineritious convexities in the fore part of the lateral ventricle. They are somewhat of the shape of a pear; they are obtuse forwards; they approach each other towards the fore part with a regular convexity, and they are narrow as they pass backwards, separating at the same time; their posterior extremity being as it were pushed out by the thalami nervorum opticorum. These last lie more under the back part of the fornix, and are more concealed when the lateral ventricle only is laid open. These bodies are called striata, from the intermixture of the medullary matter, which gives the appearance of striæ when they are cut. They descend down to the base, and give origin to the first pair, or olfactory nerves*. The striæ of medullary matter pass from above downwards, they therefore appear in the horizontal sections of this body like white points. A superficial horizontal section of the corpora striata shows those striæ connected with the medullary matter of the middle and posterior lobe. A deeper incision brings into view a mass of cineritious substance betwixt those striæ and the medullary matter of the middle lobe. Another incision shows the course of the striæ altered, and brings into view the connection betwixt the corpora striata of each side, by means of the anterior commissure†.

* Sommerring.

† "*Hæc pars commune ſenſorium eſt*, quod ſenſibilium omnium ictus a nervis cujuſque organi dilatos accipit adeoque *omnis ſenſionis perceptionem afficit*; cujuſmodi ſenſibilium ictus, cum hinc ulterius in cerebrum trajiciuntur, *ſenſioni* ſtatim imaginatio ſuccedit; atque inſuper hæc corpora, uti ſenſuum omnium impetus, ita

The COMMISSURA ANTERIOR is a cylindrical medullary cord, which unites the fore and lower part of the corpora striata, and which spreads its connections for a full inch and a half into the middle lobe of the brain upon each side. We see it stretched transversely immediately under the anterior crura of the fornix. It is in figure like a bow; its extremities stretching (with a convexity forward) into the middle portion of the brain towards the extremity of the fossa silvii, where it terminates in the medullary matter of the middle lobe of the brain.

The THALAMI NERVORUM OPTICORUM are hid by the posterior angles of the fornix, and the plexus choroides: we do not see them fully until we have lifted the fornix and the velum or membrane which stretches under the fornix. They are somewhat of an irregular oval shape; they are whiter than the corpora striata, their surface being chiefly of medullary matter. Internally they are cineritious; and the medullary and cineritious matter is blended in striæ like the anterior tubercles of the ventricles on the corpora striata.

The thalami nervorum opticorum, having their convex surface towards each other, unite under the fornix by what is called the COMMISSURA MOLLIS, in opposition to the commissura magna, which is the corpus callosum; the commissura anterior, which unites the fore part of the corpora striata; and the commissura posterior, which is yet to be described.

Thus the soft commissure of the brain, or the union of the optic thalami, is so soft that the slightest force will tear it, or in dissection, the parts being unequally supported, the thalami will be separated and this connection lost*. After such separation of the tubercles there remains very little appearance of their having been united. Sabbatier, after the most careful dissection, says expressly that he could never observe this union, and he conceives, that in the smoothness of the contiguous surfaces he has a proof of there never being such a union; but he goes on to say, "The fruits of my research were, that I constantly found a soft cord of a cineritious colour, and about a line or a line and a half in diameter passing betwixt them."

I have seen, when the ventricles were distended in hydrocephalus, and the communication betwixt the three ventricles enlarged to a square cavity of nearly an inch in diameter†,

motuum localium ſpontaneorum primos inſtinctus ſuſcipiunt." Willis, Edit. 4. p. 43.

* Morgagni and Vicq d'Azyr ſay they have ſeen this commiſſure double: it may, however, have been a partial laceration of it.

† In quadrupeds the adheſion is more extenſive.

that this union was drawn out to some length, but still was above half an inch in diameter. The commissura mollis is exceedingly soft, of a cineritious colour, and vessels are sometimes seen to cross upon its surface. It seems to be the continuation of the grey or cineritious substance which covers the internal surface of the optic thalami.*

Towards the fore part of the thalami we have to observe a peculiar eminence or convexity, viz. the ANTERIOR TUBERCLES of the optic thalami. In making a horizontal section of the thalami, we find that we cut across a medullary streak or cord which descends from this tubercle to the mamillary processes, or corpora albicantia, in the base of the brain.† Its course is deep in the substance of the brain, and somewhat oblique. The limits of the thalami externally are contiguous to the corpus striatum, but betwixt them there intervenes a white medullary tract, which is continuous with the medullary striæ, and which, as it marks the limits of the two great tubercles of the lateral ventricles, takes a course inwards towards the anterior pillars or crura of the fornix and middle of the anterior commissure. The surface of this tract, as seen in the lateral ventricle, is the TENIA SEMICIRCULARIS GEMINUM, which we shall presently more particularly describe.

To understand the further connections and importance of the optic thalami we must dissect the base of the brain. There we find that it is through the corpora striata, and the thalami nervorum opticorum, that the crura cerebri establish their extensive connection with the internal mass of the brain; particularly we find that the crura shoot up into the back and lower part of the thalami.

Here on the lower part also we may observe the TRACTUS OPTICUS, which we may trace backwards from the optic nerves. They surround the crura cerebri with a semicircular sweep, swelling out at the same time, and terminating in three considerable tuberosities: they are finally confounded with the lower part of the optic thalami;‡ at the same time there runs up a division of it into the nates.

The TENIA SEMICIRCULARIS GEMINUM is the tract of the

* Mais il n'y a point de continuité, proprement dite, entre la ſubſtance intime de ces couches et la commiſſure molle dont il s'agit. Vicq d'Azyr, Planc. de Cerv. p. 23.

† See Vicq d'Azyr, plate xii. Mem. de l'Acad. Royale, 1781, p. 528, and plate 2, fig. 5.

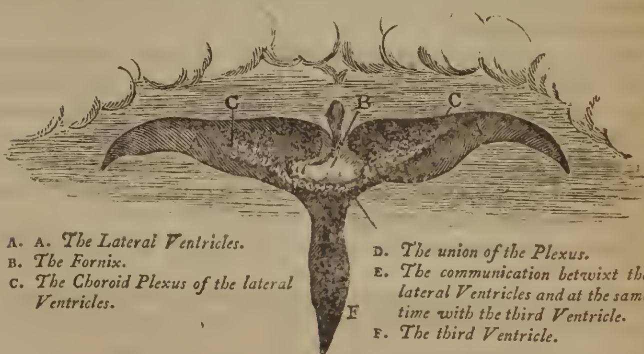
‡ Willis ſeeing the firſt and ſecond pair of nerves ſo cloſely connected with theſe tubercles, and ſuppoſing, as we have mentioned in a former note, that the corpora ſtriata were the common ſenſorium, concludes, "hinc ratio patet, cur odores ſine olfactus objecta ipſum adeo cerebrum feriunt, et immediate afficiunt; item cur inter viſionem et imaginationem communicatio citiſſima habetur." P. 44.

medullary matter, which is betwixt the two great anterior tubercles of the lateral ventricle, the corpus striatum and thalamus nervi optici. Towards the fore part of this tract its surface is covered with a layer of a semi-transparent greyish matter, through which we see the veins which pass from the surface of the corpora striata to join the vena galeni.* Sabbatier makes the anterior extremity of this medullary body join the anterior pillar of the fornix : Haller makes it join the anterior commissure : and Vicq d'Azyr says they separate again, where they seem to unite forwards and lose themselves on the corpora striata. Their posterior extremities are lost in the hippocampi ; they thus form a kind of longitudinal commissure which establishes a communication betwixt the fore and back part of the cerebrum.

OF THE THIRD VENTRICLE.

THE third ventricle does not at all answer to the conception we form of the ventricles from the lateral ones. It is a mere sulcus, lying betwixt the thalami nervorum opticorum, and betwixt the crura cerebri, which are continued down from these tubercles. It is a longitudinal slit, rima, or gutter-like cavity, which is made irregular, and is divided by the union of the optic thalami ; and finally, it is canopied by the fornix and vascular velum which stretches over the thalami.†

Plan of the communication of the Lateral and third Ventricles, represented by a Perpendicular Section.



A. A. *The Lateral Ventricles.*
B. *The Fornix.*
C. *The Choroid Plexus of the lateral Ventricles.*
D. *The union of the Plexus.*
E. *The communication betwixt the lateral Ventricles and at the same time with the third Ventricle.*
F. *The third Ventricle.*

* "Quelquefois il se detache du tænia semicircularis entre le corps strie et la couche optique un filet blanc, que faissant un angle très aigu, soit en devant, soit en arrière, monte à une certaine hauteur sur le corps cannele." Vicq d'Azyr, Mem. de l'Acad. Royale, 1781, p. 530.

† "Hanc caveam ventriculum tertium vulgo vocant, quæ et ipsa cum plena sint omnia nihil est nisi contiguorum thalamorum limes." Haller.

The third ventricle opens forward and upwards into the two lateral ventricles, and under the common communication it opens into the infundibulum. Backwards it is continued by a canal which passes under the tubercula quadrigemina, or nates and testes, into the fourth ventricle. The bottom of the third ventricle is closed by a small stratum of cineritious matter, *cloison pulpeuse du troisieme ventricule ;* this fills up the space betwixt the junction of the optic nerves and the anterior commissure. We see it when dissecting the base of the brain.—Lifting the optic nerves, we shall find it strengthened by the pia mater, and consisting of striæ which pass obliquely backwards and downwards, and some of which, while they adhere to the optic nerves, pass into them.

As we have found that the pia mater could be traced into the lateral ventricles, and as by tearing with the probe the connections of those membranes we could penetrate into the lateral ventricle without piercing the substance of the brain ; so here we can penetrate into the third ventricle, which is deepest of all ; and also into the fourth, without lacerating the substance of the brain. Thus, after raising the vascular membrane of the base, we can pass a probe under the corpus callosum backwards into the third ventricle, and by raising the cerebellum from the medulla oblongata, and separating the adhesions of the pia mater, we get access to the fourth ventricle. We conclude then, that the ventricles are not formed, as we should at first conceive, in the substance of the brain, but that they are formed by the replication and foldings of the convolutions of the brain.

Plan of the Inflections of the Pia Mater.

See foot Note.

OF THE INFUNDIBULUM.

As I have explained in my tables of the brain, there is much confusion regarding the terms vulva and anus. Vulva is the space by which the three ventricles communicate, as seen when the fornix is lifted, viz. betwixt the thalami nervorum opticorum and before the commissura mollis. The anus is behind this commissure, and near the nates and testes ; both these are mentioned as communications betwixt the ventricles : but we know that the union of the plexus choroides, of the two lateral ventricles, and of the termination of the velum under the anterior part of the fornix, leaves the vulva free. But the velum spreading over the thalami, and under the posterior part of the fornix, closes up the anus ; and it appears as a communication similar to the other only when the velum is torn up.

EXPLANATION OF THE PLATE.

1. The pia mater defcending betwixt the hemifpheres to the corpus callofum.
2. Betwixt the pofterior lobe of the cerebrum and the cerebellum.
3. Under the fornix in form of the velum.
4. Into the inferior horn of the lateral ventricle.
5. Into the bottom of the fourth ventricle.

If we pass a probe gently downwards and forwards from the vulva or foramen commune anterius, or communication betwixt the ventricles, we pass it into the infundibulum. The INFUNDIBULUM is a funnel of a soft cineritious matter, which leads from the bottom and fore part of the third ventricle towards the glandula pituitaria, which is seated in the sella turcica of the sphenoid bone.

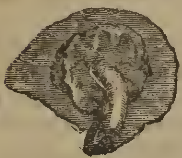
The infundibulum is formed of cineritious matter, which is continued from the bottom of the third ventricle, and which adheres to the back part of the optic nerves; or, according to Warthon, of an external membrane with cineritious matter internally. Its cavity becomes contracted before it reaches the glandula pituitaria. Whether it be really capable of conveying the fluids of the ventricles, or whether it be actually pervious, is likely to remain a disputed point. Tarin, and M. Adolphus Murray, and Haller, believe with the older writers that it is pervious. Soemmerring and Vicq d'Azyr have in their experiments found it shut.* But to the opinion that the infundibulum conveyed the superfluous moisture from the ventricles,† it did not seem necessary to Vieussens that we should find it to have a cavity in all its length. He conceived that where the apparent cavity terminated, less visible pores were continued towards the gland.

* "Sed non ad apicem usque pervium." Soemmering.

† "Structura, situque infundibuli spectatis, connexionis, et societatis, quam cum cerebro, et glandula pituitaria habet, rationibus æquo judicio perpensis, unicum illius usum esse, ut aquosum, seu lymphaticum quemdaèm cerebro depluentem humorem, majoris, ad instar vasis lymphatici excipiat et pituitariam versus glandulam sensim transmittat, non autumare non possumus: etenim eum intertextarum plexibus choroïæis glandularum usus sit, ut sanguinis calvariam subeuntis, spiritusque animalis materiam suppeditantis, aquosiorem partem, desinentibus in ipsas ab arteriis depositum excipiant, quæ deinceps per insensiles rarissimæ, qua obducuntur, membranæ poros, sensium transfluit, et partim per vulvam partimve per anum, in tertium cerebri ventriculum delabitur; nullus esse videtur ambigendi locus, quin aquosus omnis humore glandulis, quæ plexuum choroïdæorum vasis interleruntur, sensim affluens, ad infundibulum deferatur." Vieussens, p. 50.—Such was the opinion regarding the œconomy of the brain, and now we have no theory, good or bad, nor any explanation of this connection of the gland with the ventricles of the brain to offer.

INFUNDIBULUM AND PITUITARY GLAND.

Gland and Infundibulum taken out.



Pituitary Gland Seated in the Sella Turcica.

What is called the PITUITARY GLAND is a reddish body of a glandular-like structure*, which is seated in the sella turcica of the sphenoid bone. It is plain upon its upper surface, or rather perhaps a little hollowed, of a globular shape below, and having a division into two lobes. The infundibulum terminates in it, piercing the dura mater, a thin lamina of which spreads over the gland. The gland, as is seen in the above plate, lies surrounded with the circular sinus, and has the cavernous sinus upon the sides; into these last, vessels have been seen to pass from the gland†, which, as Soemmerring observes, were probably veins. A distinction of substance has been observed in this gland, and it is by some considered as a part of the brain, or being like the cineritious substance, it has been supposed that it gave nerves to the fifth or sixth pair.

It was conceived that the body receiving the superfluous moisture of the brain, conveyed it into the nose; or into the neighbouring sinuses‡. To countenance this opinion, there was no want of cases proving the accumulation of the fluids of the ventricles, in consequence of the schirrus of this gland§, while in truth dissection has shown no connection betwixt the diseases of the ventricles and pituitary gland. M. Littre gave

* It perhaps has only the form of a gland. Haller ſays " non acinoſa quidam, neque nullius alterius glandulæ ſimiles, quæ potius cerebri quedam ſit appendix." See alſo Bordeu, recherch. Anatomiq. ſur les Glands.

† Adolph. Murray de infundib.

‡ Lower Tract. de Corde.

§ Schneider (de catarch.) firſt oppoſed this theory; ſhowed that there was no communication betwixt the brain and the noſe, and maintained that no fluid, not even the blood which flowed from the noſe, had any connection with the brain: he was ſupported by other able anatomiſts. The old opinion was revived by M. *Bouillet Elements de Medecine pratique.*

both a vascular structure and muscular fibres to this body, and conceived that its operations brought down the water and air from the ventricles of the brain*.

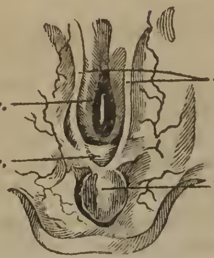
THE TUBERCULA QUADRIGEMINA.

THE tubercula quadrigemina, or nates and testes, are seen when we continue to lift back the posterior part of the fornix and corpus callosum, and when we have lifted back the velum with the vena galeni. We find, in doing this, that the velum is connected with the pineal gland, which is seated upon these tubercles. The tubercula quadrigemina are not in the cavities or ventricles of the brain, but are seen upon lifting and turning forward the posterior lobes of the cerebrum from the cerebellum.

These four tubercles are behind the third ventricle, and above the fourth. As they are immediately in the centre of the brain, they form a kind of commissure, and they both communicate with the tubercles, from which the tractus opticus emerge. The uppermost two are the NATES, the lower are the TESTES; the former are less white than the latter. A little under the inferior tubercle, we find sometimes a small tract of medullary matter, which extends to the thalami nervorum opticorum, and the crura cerebri. And from the lower part of the testes there projects backwards, connecting itself with the crura cerebelli, a thin medullary lamina, which is the VALVULA VIEUSSENII, PROCESSUS a CEREBELLO AD TESTES, or VELUM INTERJECTUM. Behind the posterior tubercle, or from this medullary lamina itself, the fourth pair of nerves take their origin. Sometimes those four tubercles are of the same size; sometimes the posterior, sometimes the anterior tubercles, are the larger: a perpendicular section of them shows a mutual communication of striæ of medullary and cineritious matter, but those are faintly seen only.

* See Littre, Mem. de l'Acad. des Sciences, 1707.

THE PINEAL GLAND.



THE pineal gland is seated above the tubercula quadrigemina, and behind the thalami nervorum opticorum; it is fixed, says Winslow, like a button. It consists of cineritious matter covered with the pia mater; its base is surrounded with medullary matter; it adheres firmly to the velum, and is apt to be displaced or torn from its pedunculi in lifting that membrane. It is a small soft greyish body, irregularly round, or of the figure of a pine-apple; or, of all things, most like the heart of a frog.* Its pedunculi, or footstalks, pass out from a transverse medullary base, which unites it to the posterior commissure. Those pedunculi pass on each side to the thalami nervorum opticorum (leaving a passage under and betwixt them to the fourth ventricle.) Their extremities pass forward upon the internal surface of the thalami nervorum opticorum, and are united to the anterior crura of the fornix.

Vicq d'Azyr remarks, that although the ideas of Galen and Descartes†, and a crowd of others are remembered only with ridicule, there are still some peculiarities in the situations and connection of this body, which mark its importance. It is composed of cineritious substance; it is in fact a prolongation of the substance of the brain, and by its pedunculi, which are like two nerves, it is connected with the thalami nervorum opticorum, with the fornix, and consequently with the corpus

* Ruyſch conſidered the ſubſtance of this gland as different from that of the cerebrum or cerebellum, and different, alſo, from all other glands.

† Alluding to their opinion of this being the ſeat of the ſoul; Willis impoſed upon this part a lower office, "Ejuſque munus non aliud omnino eſſe quam aliarum glandularum quæ juxta vaſorum ſanguiferorum concurſus diſponuntur; nempe ut humores ſeroſos, a ſanguine arterioſo depoſitos, excipiat, et in ſe retineat; donec aut *venæ* depletiores factæ eoſdem reſorbeant, aut lymphæ ductus (ſi qui adfuerint) eos extra convehant." Willis, p. 46.

callosum, the hypocampus and corpora albicantia, which are themselves the centre of union to several medullary cords; therefore he concludes that the pineal gland must be an important organ*.

The pineal gland has often in it little peculiar grains and calculi†. It has a great variety of form and size; I have found it surrounded with pus in an ideot boy, who was accustomed to wander about the Leith glass-houses. He died with symptoms of hydrocephalus, and in his ventricles, accordingly, there was found much fluid. Malacarne gives a case of its having degenerated into hydatids, like a cluster of grapes. It has not been found upon dissection in some cases.

POSTERIOR COMMISSURE.

The base of the pineal gland is connected with the posterior commissure of the brain. This commissure is seen like a cord, or like the anterior commissure, towards the back part of the third ventricle, before the tubercula quadrigemina, and above the iter ad quartum ventriculum. Betwixt this commissure and the base of the pineal gland, we have to observe two or three medullary filaments, not passing from the gland, but lying parallel to the commissure. But this part of the brain, which appears like a cord, does not deserve the name of commissure; it does not pass on each side into the substance of the brain as the anterior one does; it is lost in the neighbouring border of medullary matter, and is merely this matter reflected, so as to have a rounded edge.

OF THE FOURTH VENTRICLE.

The fourth ventricle descends perpendicularly before the cerebellum; it is inclosed above by the valvula cerebri, below by the medulla spinæ, and on the right and left by the crura cerebelli.

* Mem. de l'Acad. Royal, An. 1781, p. 533. See Obſerv. par M. Mechel ſur la gland pineale, ſur la cloiſon tranſparente, et ſur l'origine du nerf de la ſeptieme paire. L'Acad. Berlin, 1765.

† "La parte anteriore della baſe n'è ordinari amente midollare, e qui appunto l' ho moltiſſime volte veduta geſſata, oſſoſa, tartaroſa e friabile, vizi, che ho trovati anche molte volte, nei picciuoli." Malacarne, part ii. p. 81. *Acervulus*; Meckel, Mem. de l'Acad. des Sciences a Berlin, 1755, fig. 1. b. b. Vicq d'Azyr, tab. xxvii. Super medulloſum conarii vinculum vel in ipſo vinculo, vel in ipſo denique acervulo, plerumque vero ante acervulum iam in fetibus inmaturis peculiares quidam lapilli, mox maiorum acervulum, mox vero duo vel tres minores acervulos conſtituentes, hclui, ſemiperlucidi, iunioribus ſemper pallidiores, annoſioribus fuſciores, infantibus ob coloris languorem et perluciditatem difficiles cognitu ſiccati albidiores et opaciores inveniuntur." Soemmerring, p. 63.

When we pass our probe obliquely backwards and downwards under the posterior commissure, it passes into the ITER AD QUARTUM VENTRICULUM, or AQUEDUCT of SILVIUS. This passage to the fourth ventricle, goes before the tubercula quadrigemina. The VALVULA VIEUSSENII, it was supposed, prevented the falling down of the moisture of the other cavities into the fourth ventricle :* it is more properly called the PROCESSUS CEREBELLI AD TESTES, being a medullary lamina spread over the ventricle and betwixt the crura cerebelli, as they rise from the ARBOR VITÆ, or the internal medullary part of the cerebellum.

From the aqueduct there is continued down upon the fore part of the fourth ventricle a kind of fissure, which Vesalius, conceiving it to have some resemblance to a writing quill, called CALAMUS SCRIPTORIUS. The same fissure or furrow is continued down some way upon the spinal marrow.

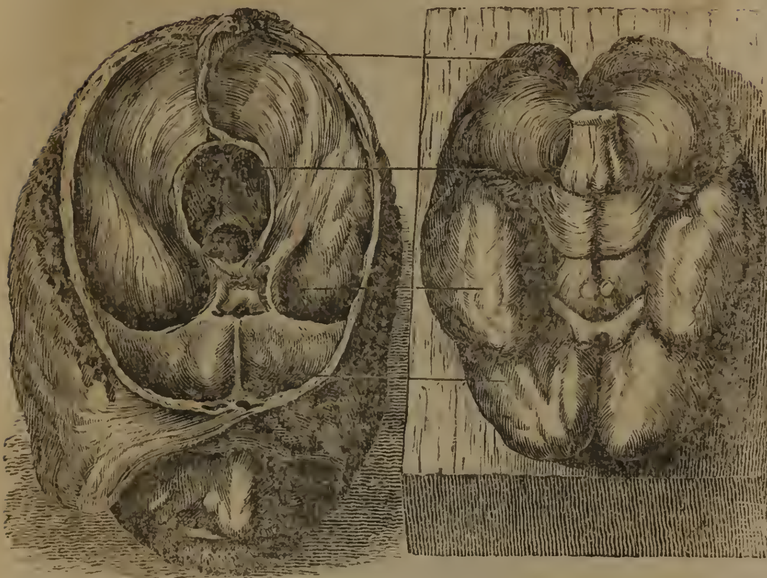
There pass up obliquely outwards, on each side of the calamus scriptorius, medullary lines, three or four in number, but sometimes seven are observed.† One of these fibres ascends to the valvula Vieussenii ; some are the origins of the auditory nerve, and one or two striæ go to form part of the eighth.

In the fourth ventricle, as in the others, are some convolutions of the plexus choroides ; these are on each side at the termination of the vermis ; they are continued out upon the base of the brain, and are seen exposed betwixt the seventh and eighth pair of nerves.

* Alveus Silvii.
† Haller, Phyſiol. tom. iv. p. 78.

OF THE BASE OF THE BRAIN AND ORIGIN OF THE NERVES.

Relation of the Brain and Scull-cap.



We have anticipated much that might have fallen to be treated of in this division of our subject; but my intention here is to give a connected view of the parts, as seen when we have raised the brain from the scull, and when, having the base presented to us, we are about to enumerate the origins of the nerves.

The first appearance which strikes us is the great proportion of the medullary matter in the base of the brain; the whole surface of the brain, while seen from above, was cineritious, but now the centrical medullary part of the brain is seen emerging from the envelopement of the cineritious matter, and, gathering together from the several internal medullary processes of the brain, it concentrates the essential properties of the encephalon, and is fitted to give out the several nerves.—Those great medullary prolongations of the cerebrum and cerebellum, are called the crura.

The CRURA CEREBRI are composed of a white fibrous medullary matter, in which also there is a mixture of cineritious

substance. They are formed from the whole central medullary part of the cerebrum; or more immediately from the inferior and lateral part of the corpora striata, and from the superior and internal part of the thalami nervorum opticorum; and, from the conflux of medullary matter, from the anterior and posterior lobes of the cerebrum. From all these various parts the medullary matter, passing downwards and backwards, forms the crura.* The crus of either side of the brain, contracting their diameters, unite at an acute angle, and are united to the pons varolii, or nodus cerebri, formed by the crura cerebelli; they pass on to form the medulla oblongata, and, as they unite with it, they raise it into the eminences, called Corpora Pyramidalia. In those processes of the cerebrum, the cineritious and medullary substances mingle with some degree of confusion; so that when we make a section of the crura cerebri near to their union with the pons varolii, we observe a substance of a dark-brown colour, surrounded with white or medullary matter. In the angle of the union of these crura cerebri, behind the corpora albicantia, and before the protuberance of the pons varolii, we observe a matter less perfectly white than the surrounding medullary substance, which forms a floor to the third ventricle. This part is perforated with a great many holes, and is the *substance perforée* of Vicq d'Azyr,† and gives origin to the third pair of nerves along with the crura themselves.

CRURA CEREBELLI.

The crura cerebelli are more exposed than those of the cerebrum; the latter lying deeper, and being comparatively smaller. They are formed by the union of the internal medullary part of the cerebellum, or the arbor vitæ. They are altogether composed of medullary matter, except near the pons varolii, where we observe a mixture of coloured striæ.

PONS VAROLII.

The PONS VAROLII, TUBER ANNULARE, or NODUS CEREBRI is formed by the union of the crura cerebri and cerebelli; those names are almost descriptive of its shape and relation to the other parts. Varolius, looking upon those parts inverted, com-

* I ſpeak ſtill of the relation of thoſe to each other, according to their natural ſituation in the ſcull.

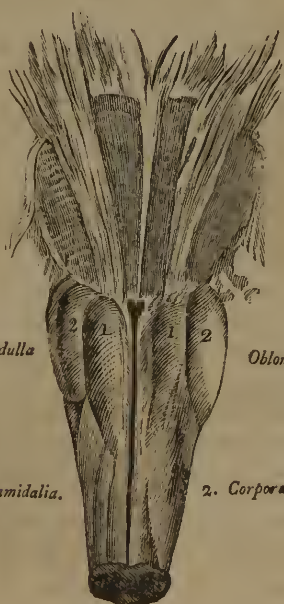
† Vicq d'Azyr makes three diviſions of this *ſubſtance perforée*—1ſt. At the roots of the tubercles, from whence the firſt pair of nerves emerge betwixt the roots of thoſe nerves, and near the origin of the optic nerves. 2. Thoſe I mention betwixt the crura cerebri. 3d. On the outer contour of the optic thalami.

pares the crura cerebri to a river passing under a bridge, and thence named it Pons. The nodus cerebri, again, is a name well applied, since this medullary eminence has much the appearance of a knot cast upon the medullary processes of the cerebrum, and is in fact the central union of the elongated medullary matter of both cerebrum and cerebellum.

On the surface of this medullary protuberance there are many transverse fibres, which, uniting in a middle line, form a kind of rapha, which, upon a superficial section, shows a longitudinal medullary line. The fibres upon the surface of this body are uniform and parallel to each other in the most projecting part; but upon the sides, they disperse to give place to the fifth pair of nerves and crura cerebelli.

A deeper incision of the pons varolii, while it shows the intimate union of the crura cerebri, cerebelli, and pons varolii, also shows the white medullary tracts which extend from the crura cerebri through the pons varolii to the corpora pyramidalia; part of these pass through the LOCUS NIGER CRURUM CEREBRI, and can be traced to the corpora striata. We see also the transverse fibres of the medullary and cineritious substance, which makes a right angle with those longitudinal tracts.

MEDULLA OBLONGATA.



Section of the Pons Varolii.

Medulla Oblongata.

1. *Corpora Pyramidalia.* 2. *Corpora Olivaria.*

The medulla oblongata is the prolongation of the substance of the crura cerebri and cerebelli, and the pons varolii; it is consequently the continuation of the encephalon, which, after giving off the nerves that pass through the foramina of the scull, enters the canal of the spine to supply the spinal nerves. The medulla oblongata is marked at its upper end by a deep sulcus dividing it from the pons varolii; but towards the spinal cavity it decreases in thickness, and there is no natural distinction or sulcus to mark the point where the medulla oblongata ends, and the medulla spinalis begins: nor perhaps is the medulla oblongata to be considered in any other light than as the beginning of the spinal marrow. When it passes the foramen magnum, it ceases to be called the medulla oblongata.

We have to observe four eminences upon the medulla oblongata, viz. two corpora pyramidalia, and two corpora olivaria. The CORPORA PYRAMIDALIA, so called from their shape, are those in the middle. There is formed betwixt them and the pons varolii (being three tubercles placed together) a little sulcus, which some have called the FORAMEN CÆCUM. Betwixt these eminences there is a longitudinal fissure, in the bottom of which there may be observed transverse little cords, which are like commissures connecting the two sides of the medulla oblongata.

The CORPORA OLIVARIA lie upon the sides of the corpora pyramidalia. They are in some degree, like them, limited by the sulcus which bounds the pons varolii, rounded above and bulging, but gradually subsiding, at their lower part, into the level of the medulla spinalis; yet they are internally different, for anatomists had observed a mixture of a yellow or cineritious coloured matter in the corpora olivaria, but Vicq d'Azyr has observed a regular oval medullary substance, or body surrounded with cineritious coloured substance, like a miniature representation of the cerebrum itself; he calls it CORPUS DENTATUM EMINENTIÆ OLIVARIS.

MEDULLA SPINALIS.

The medulla spinalis, from its structure, its two substances, its membranes, and its use, as evident in the consequences of injury, must be considered as an elongation of the brain. Its name implies its situation contained within the tube of the spine. Though chiefly composed of medullary matter, it is not entirely so; for there is an irregular, central, cortical substance, through its whole extent, having something of a cruci-

al form in the section of this part.* There are continued down from the calamus scriptorius behind, and the rima, formed by the corpora pyramidalia, before, two fissures which divide the spinal marrow into lateral portions. On the back part, however, the fissure is very little distinguishable. Into the anterior one the little vessels penetrate to supply the cineritious matter with blood. The spinal marrow diminishes in thickness as it descends in the neck ; but below the giving off of the brachial plexus it again enlarges, then continues gradually to diminish.

The tube of the vertebræ is connected by a strong ligamentous sheath, which runs down the whole length within the tube. The dura mater, after lining the internal surface of the cranium, goes out by the great foramen, and forms a kind of funnel; at the occipital foramen it is united firmly to the ligament. Under this, however, it forms a separate tube. The tunica arachnoides again adheres loosely, having a kind of secretion within it, while the pia mater closely embraces, and is intimately united to the medullary matter.

From betwixt the ninth nerve and vertebral artery to the second and third lumbar nerve, there is a membraneous connection betwixt the lateral part of the spinal marrow and the dura mater of the spine. From the manner of its connection to the dura mater, by distinct slips irregular and pointed, it is called the Ligamentum Denticulatum, or Dentatum.

SCHEME AND GENERAL DESCRIPTION OF THE ORIGINS OF THE NERVES OF THE ENCEPHALON AND SPINE.

In enumerating the nerves which pass from the cranium, I shall keep to the old way of Willis, counting only nine nerves of the encephalon. I do not find that the subdivisions of the nerves in this classification, and the description of the several fasciculi, of which the pairs of nerves are composed, cause intricacy. It rather, I am from experience convinced, connects some circumstances with many of the pairs of nerves thus enumerated, to which the memory of the student can attach.—The common enumeration seems a natural one ; it serves well the purpose of dissection, and consequently will never be entirely exploded. The use of new classifications and arrangements, and names, whilst we must also retain the old, adds much to the intricacy of demonstration.

* The furface of the fpinal marrow has alfo been obferved to be of a darker colour, and in large animals diftinctly cineritious. (Dr. Monro's Nervous Syftem.)

From the olfactory nerve to that which passes out betwixt the cranium and first vertebra, there are nine nerves.*

1st pair—Olfactory nerves.	*Carunculæ mamillares Math.* de Grad. *Processus ad nares.* Gonth d'Andernc. 8^{um} par, Spigel. 1st pair of Willis.
2d pair—Optic nerves.	*Nervus visivus, seu visorius.*—Carpi. 1^{m} *par antiquorum.* 2d pair of Willis.
3d pair—Motores oculorum.	2^{um} par, Fallop. et Vesal. Nerfs moteurs communs des yeux.—Winslow. 3d pair of Willis.
4th pair—Trochlearis.	*Minor propago* 3^{ii} *Paris, id est* 5^{i} *recentiorum, Fallop.* *Gracilior radix* 3^{ii} *Paris, id est* 5^{i} *recentiorum.* Vesal. *Nervus qui prope nates oritur.* Eustach. 9^{um} par Cortes : et Columb. 4th pair ; or, pathetic nerves of Willis.
5th pair—Trigemini.	*Nervus anonymus trigeminus multorum.* 3^{um} par Fallop. et Vesal. 5th pair of Willis. Trijumeaux of Winslow.
6th pair—Abductores.	4^{um} par Fallop. *Radix gracilior* 5^{i} *Paris, id est* 7^{i} *recentiorum Vesal.* *Par oculis prospiciens.* 8^{um} *par* Capp. Bauhini. 6th pair of Willis. Nerfs oculo-musculaires, ou moteurs externes de Winslow.

* In the following table, I am of courſe much indebted to the ſynonymic of Vicq d'Azyr.

7th pair	Auditory nerves.	2^{um} par Alexand. Benedict. 4^{um} par Carol. Stephan. 5^{um} par Vesal. et aliorum. 6^{um} par V. Horne. Portia mollis, of the Moderns.
	Nervus communicans faciei.	*Distinctus a molli nervus.* Fallop. *Portio, ut præcedens*, 5^{i} *Paris, id est* 7^{i} *recentiorum.* Vesal. Portio dura, of the Moderns. Le petit sympathique, of Winslow. Facial nerve.
8th pair	Glosso-pharyngeus.	*Qui ad musculus linguæ et faucium tendet. Fallop.* Le rameau lingual de la 8^{e} paire of Winslow. 8th pair d'Andersch. Superior fasciculus of the 8th pair of Willis. *Glosso Pharyngeus.* Haller.
	Par vagum.	*Nervus sextus* Galeni *et aliorum.* 5^{a} *conjugatio* Carol. Stephan. 7^{um} par Alex. Benedict. 6^{um} par Casp. Bauhini. 9^{um} par Bidloo et Andersch. 8th pair of Willis. Le moyen sympathique of Winslow.
	Spinal accessory nerve.	The spinal nerve.
9th pair—Lingual.		7^{um} par Fallop. Vesal *et aliorum.* 11^{um} par Bidloo. 10^{um} par Andersch. *Par linguale medium, vel nervus lingualis medius.* Haller. Soemmering *et aliorum.* The hypoglossal, *sublingual*, or gustatory. The 9th pair of Willis.

10th pair—Suboccipital nerve.	10th pair of Willis. 1st spinal, or cervical nerve, of Haller. I count this the first cervical nerve.

FIRST PAIR; OR, OLFACTORY NERVES*.

The olfactory nerve is soft and pulpy, and soon resolved by putrefaction; therefore, we should not be surprised that it was neglected by the Ancients†. It adheres firmly to the lower surface of the anterior lobe of the brain, but it does not take its origin here. It is of a triangular shape, as if moulded to the sulcus in which it lies; by being sometimes sunk into the sulcus more or less on one side than the other, it has the appearance of being larger on one side than the other. It takes its origin by three medullary tracts‡; 1st, From the corpus striatum; 2d, From the medullary matter of the anterior lobe; 3d, From the fore and under part of the corpus callosum§. When a section is made of it, we observe in it a cineritious portion.

Towards the fore part, this nerve expands into a bulbous oval lobe, which consists of a semi-transparent cineritious substance. This lies upon the crebriform plate, and from it are sent down the nerves which expand upon the membrane of the nose, and compose the organ of smelling||.

* In the present enumeration and description of the nerves, we attend chiefly to their relation to the brain. In the introduction to the next part of this volume, they will be found arranged and classed previous to the detail of their minute distribution.

† The olfactory nerve is in brutes a large prolongation of the substance of the brain, and is the proper mamillary processes. Their olfactory nerves have a cavity or ventricle in them, and it was natural for the Ancients to imagine that the pituita of the brain was from this strained through the crebriform plate into the nose. Vesalius proved the absurdity of this opinion; it was, however, revived by Dulaurens, who was perhaps more of a courtier than an anatomist. But Willis is not much better, when he describes the proper use of these nerves. He supposed the crebriform plate of the æthmoid bone to prevent bodies from passing up into the brain ("ne quid asperi aut molesti cum illis una ad cerebrum feratur"); while the lymph in those nerves corrected the two pungent odours; "odorum species demulcere easque sensorio quadantenus præparare."

‡ Or we say that the external root generally splits, having two fasciculi. See Prochaska, tab. 1.

§ Vicq d'Azyr, M. de l'Acad. Roy. 1781.—"Breviores fibræ medulloræ cum longioribus exterioribus connexæ nonnunquam cineream particulam excipiunt." *Soemmerring*

|| Duverney has shown us, that those nerves passing through the crebriform plate become firm nerves, like those in the other parts of the body. They are to be seen by tearing the membrane of the nose from the bone.

SECOND PAIR; OR, OPTIC NERVES*.

The optic nerves arise from the posterior part of the optic thalami, and also (and perhaps more directly†) from the tubercula quadrigemina. When we trace the optic nerves backwards into the tractus opticus, we find them taking a circle round the crura cerebri, then enlarging, each forms a tubercle towards the back part of the thalamus opticus, and afterwards unites with the posterior tubercle of the thalamus opticus; at the same time a division stretches towards the testes, while betwixt the posterior tubercle of the thalamus opticus and the nates, there is an intermediate communication. When those tubercles are fairly exposed by separating the middle lobes of the brain, and dissecting away the tunica arachnoides and pia mater, they are seen smooth, and formed of medullary matter; which is uniformly continued from the one to the other, following their gentle convexities with an uninterrupted surface. Within those tubercles is a mixture of cineritious and medullary matter, and, especially, there is a distinct streak which passes from the tractus opticus to the nates.

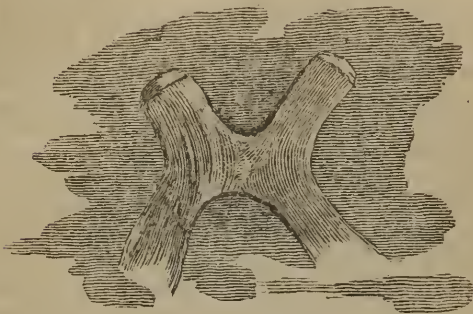
Thus there is a communication betwixt the nates and testes, and the optic nerve; but we must still consider the nerve as arising in a peculiar manner from the thalamus opticus, while at the same time it receives additions from the crura cerebri, where the nerve adheres closely to the crura.

Tracing the optic nerves from their origin in the brain towards their exit from the scull, we find them approaching gradually and uniting just before the corpora albicantia and the nfundibulum.

* The optic nerves were the firſt pair of Galen and many of the older anatomiſts, they being ignorant of the olfactory nerves.

† "Les nerfs optiques naiſſent en arriere des eminences nates et teſtes vers la partie poſterieure de celles que l'on nomme les couches des nerfs optiques." *Sabbatier.*

Section of the Union of the Optic Nerve.



Since the days of Galen, it has been a disputed point, whether there is a union simply of the nerves, or a decussation. Fishes have the nerve arising from one side of the brain passing to the eye of the other side: they cross, but they do not unite. Birds have but one optic nerve arising from the brain, which splits and forms the right and left optic nerves. Vesalius dissected a young man at Padua, who had lost his eye a year before; at the same time he dissected a woman, whose eye had been lost a long while. In the latter he found the nerve of that side smaller, firmer, and of reddish colour, through all its extent. In the young man he observed no effect upon the nerve. He also gives a plate of an instance in which he found the optic nerves pass on to the eyes of the same side from which they take their origin, without adhering at all.

Valverda, a physician of Spain, who travelled into Italy, and studied the Works of Vesalius and Human Dissection, says, that at Venice he had frequent opportunities of assuring himself that there was no decussation; for robbers were punished for the first offence by losing one of their eyes; and for the second by death. Riolinus, Rolefinkius, and Santorini, give observations of the nerve of the injured eye being small and shrivelled, and of their having traced them past their union to the same side of the brain with the eye to which they belonged. Vicq d'Azyr, who, of all authors I conceive to be the best authority upon such subjects, is decidedly of opinion that there is no decussation. Zin also agrees with the opinion of Galen, that there is an adhesion and intimate union of substance, but no crossing of the nerves. Soemmerring deems it sufficient to point out the authorities on both sides of

the question, while he has no decided opinion whether there be a perfect decussation or not*. Porterfield, while he allows the intimate union of the optic nerves, has several observations, proving that they have no intersection or decussation.

Sabbatier, encouraged by the authority of Morgagni, says, that he could trace the affection of the nerve of the injured eye no farther than to the union. He discredits the accounts of their having been traced to the same side of the brain, and believes the assertions to be the consequence of previous opinion and prejudice. There are certain observations of Valsalva, Cheselden, and Petit, which seem to prove, that where the brain is injured, it is the eye of the opposite side that is affected†. After their union the optic nerves are much contracted in diameter; still the optic nerve, is the largest of the head, excepting the fifth pair. It is the firmest of all the nerves of the senses, but softer than the other nerves‡.

What remains to be said of the optic nerves, falls more naturally to be treated of when speaking of the organ of vision.

THIRD PAIR OF NERVES; MOTORES OCULORUM.

The third pair of nerves arise from the internal margin of the crura cerebri, and the perforated medullary matter which is betwixt the crura. The delicate filaments of this nerve cannot be traced far into the substance of the brain, but still we may observe them spreading their filaments, and traversing the dark coloured spot which we have already mentioned to be visible in the crura cerebri. Some anatomists have said, that the third pair of nerves had an origin also from the nates and testes. Ridley describes them as rising from the pons varolii§.

In relation to the arteries, those nerves are betwixt the posterior artery of the cerebrum, arising from the division of the basilar artery and the anterior artery of the cerebellum‖. They diverge from each other as they proceed forwards, and each penetrates under the anterior point of the tentorium by

* "Ergo, utrum omnes nervorum fibræ, an quædam tantum mutuo ſe ſecent, certe ſtatui nequit."

† If Petit and others are proving that the optic nerves are affected in the ſide oppoſite to the injury of the brain, they are proving that they have no decuſſation; for if they had, it would counteract that effect, which, from the ſtructure of the brain, they muſt have in common with the other nerves.

‡ Soemmerring.

§ They ſeem to come from the angle betwixt the crura cerebri and pons varolii. They are flat near their origin, but become round and firm.

‖ "Cette diſpoſition peut expliquer pourquoi on éprouve tant de péſanteur aux yeux aux approaches du ſommeil, dans l'ivreſſe & dans certains eſpeces de fievre." *Sabbatier.* This is a mechanical and a moſt improbable way of accounting for ſuch an effect.

the side of the cavernous sinus, and passes through the foramen lacerum. In the general description it is sufficient to say, that they are distributed in common to all the muscles of the eye.

THE FOURTH PAIR OF NERVES.

THE fourth pair of nerves, pathetici, or trochleares, are the smallest nerves of the encephalon, being not much larger than a sewing thread. This nerve comes out from betwixt the cerebrum and cerebellum, passes by the side of the pons varolii, and after a long course pierces the dura mater behind the clynoid process, runs along for some way in a canal or sheath, formed by the dura mater; it then passes through the cavernous sinus, continues its course onwards through the foramen lacerum to the orbit, and is finally appropriated to the superior oblique muscle of the eye.

The origin of the fourth pair, if we take implicitly the descriptions of authors, seems to have a much greater variety than any of the other nerves; so that it is common to say, the fourth pair of nerves arise about the region of the nates and testes*. The trochlearis arises sometimes by two filaments, but more commonly by one undivided root†. This root is seen to emerge from a point betwixt the medullary lamina of the cerebellum, or valvula Vieussenii, and the lower of the tubercula quadrigemina‡.

From the connections of the parts whence this nerve arises with the rest of the brain, it is presumed, that this fourth pair of nerves has a very immediate and universal connection with the internal parts of the brain; yet there is nothing in the final distribution of the nerve, which should incline us to believe that there should be any particular provision in its origins.

* "Pone corpora bigemina posteriora mox paullo superius, mox paullo inferius, mox magis exteriora, mox magis interiora versus radice simplici, duplici, triplici, quin et quadruplici oritur.—Nonnunquam origo ejus in cerebri valvula, nonnunquam in ipso frenulo patet ut humore ventriculi quarti alluatur." *Soemmerring*, vol. iv. p. 209.

† Santorini says, they have three roots or little fasciculi. Wrisberg following Vieussens, says, the fourth pair arises from the valvula cerebri. Vicq d'Azyr. See Haller, fas. vii. tab. 3. "Origo alius simplex est, alius duplex; quando simplex est, a processu a cerebello ad testes exterius prodit, quam est transversa stria, quæ eos processus conjungit." Haller Phys. vol. iv. p. 208.

‡ "Et souvent ils se confondent avec un tractus medullaire placé transversalement au-dessus de la valvule du cerveau." Vicq d'Azyr. This nerve, says he, cannot be followed into the anterior part of the brain from its extreme delicacy, and because it is formed from the medullary substance itself, without the admixture of filaments to give it strength. He quotes those words of Soemmerring:— "Continua medulla oritur."

FIFTH PAIR OF NERVES; TRIGEMINI.

THE fifth nerve of the brain arises from the fore and lowest part of the crura cerebelli, where they unite with the pons varolii. The origin of this nerve may be divided into two portions: an anterior is small, and somewhat elevated above the other. The posterior part of this origin takes its rise a little lower than the anterior part. These two origins of the nerve are connected by cellular membrane, and have betwixt them a little groove, in which not unfrequently an artery creeps. According to Santorini, the anterior of these divisions is formed by the transverse fibres of the pons varolii, and the posterior by the crura cerebelli. But this nerve appertains truly to the cerebellum; and Vicq d'Azyr could never, except in one dissection, perceive that any of its fibres arose from the pons varolii*. The nerve of the right side has been observed sometimes larger than that of the left.

This fifth nerve, the largest of the scull, passing forwards and downwards, slips in betwixt the lamina of the dura mater, opposite to the point of the pars petrosum of the temporal bone. It is here firmly attached to the dura mater, and forms a flat irregular plexus. From this plexus there pass out three great branches:—1st, One to the socket of the eye and forehead, through the foramen lacerum; 2d, One to the upper jaw and face, through the foramen rotundum; and 3d, One to the lower jaw and tongue, passing through the foramen ovale.

SIXTH PAIR OF NERVES; OR, ABDUCENTES†.

THE sixth nerve of the scull seems to arise from betwixt the pons varolii and medulla oblongata. In the origin of its fibres it has, however, much variety; and authors differ very much in this point of the description‡. We may say, however, that the sixth pair of nerves arises from the corpora pyramidalia.—Sometimes the nerve rises in two branches, which do not unite until they are entering into the cavernous sinus§. The sixth nerve is in size somewhat betwixt the third and fourth: it passes forward under the pons varolii, until near the lateral

* "Oritur e nodo cerebri, prope cerebellum duabus partibus, &c." Soemmerring.

† Or, motores externi.

‡ Simple as the anatomy of the nerve is, Vieuſſens, Morgagni, Lietaud, Winslow, Sabbatier—all differ in their account of the origin of this nerve in ſome little circumſtance; and Vicq d'Azyr gives ſix varieties of it.

§ Sabbatier.

and lower part of the body of the sphenoid bone: it thence continues its route forwards and downwards by the side of the carotid artery, through the cavernous sinus: here it seems increased in size.—It gives off that small twig which anatomists account the beginning of the great sympathetic nerve.—The sixth nerve, after giving off this delicate thread, passes on through the foramen lacerum to the abductor muscle of the eye.

SEVENTH PAIR OF NERVES; OR, AUDITORY.

THE seventh nerve arises from the posterior and lateral part of the pons varolii, at the point where it is joined by the crura cerebelli.

But this seventh pair of Willis consists of two parts; the facial nerve or portio dura, and the auditory or portio mollis; the last is the larger and posterior portion.*

The PORTIO DURA comes out from the fossa formed betwixt the pons varolii, corpora olivaria, and crura cerebelli;† and upon a more careful examination we find it rising distinctly from the crus cerebelli.

The origin of the portio mollis, of the seventh pair, is to be traced from the fore part of the fourth ventricle.‡ We observe passing obliquely upwards from the calamus scriptorius several medullary striæ; those vary in number from two to seven, and are sometimes not to be discerned.§ To these are added certain fibres arising from the pons varolii, and as these fibres proceed from their origin, they become still more distinctly formed into fasciculi. The whole of this portio mollis is larger than the third nerve, firmer than the first, but less so than the second pair: it forms a kind of groove which receives the portio dura. The portio mollis and portio dura entering

* And we may add a third portion; the portio media of Wrifberg.

† "Foffe de l'eminence olivaire," of Vicq d'Azyr.

‡ Prochafka, fpeaking of the fourth ventricle, continues thus:—"Super has ultimas eminentias solent medullares candicantes quafi fibræ decurrere, a quibus proprie originem portionis mollis nervorum auditoriorum faltem pro parte deducunt." (Ridley, Haller, Lobftein, cum per antiquo auctore Piccolhomini et etiam recentiffimus Soemmerring.—"Ego poftquam multoties in lineas illas medullares in quarto ventriculo inquifiviffem, dicere poffum, non femper illas in originem nervi acuftici mollis terminare; nonnunquam enim paulo fupra nonnunquam paulo infra definunt, aliquando in uno latere, & haud raro utrinque defiderantur, ita ut ex his obfervationibus perfuadear illas medullares quarti ventriculi ftrias ad originem portionis mollis nervi acuftici minime effentiales effe." Prochafka, tab. iii. f. f.

§ It is a curious circumftance, fhould future obfervation confirm it, which has been mentioned by Santorini, that thofe origins of the auditory nerve have been obferved particularly ftrong in a blind man, whofe hearing had been very acute.

the meatus auditorius internus of the petrous bone, the former is divided into four portions which pass to the several parts of the internal ear. The latter passes through the ear, and comes out by the stylo-mastoid foramen behind the ear, spreads upon the cheek, and forms the principal nerve of the face.

EIGHTH PAIR OF NERVES.

To understand a very intricate demonstration, it is necessary to recollect that the eighth pair of nerves, as they have a relation to the brain, consists of three distinct nerves.—These are, 1st, The GLOSSO-PHARYNGEAL NERVE ; 2d, The PAR VAGUM ; 3d, The SPINAL ACCESSORY.—Taken all together, they arise from the superior and lateral part of the medulla oblongata.

The GLOSSO-PHARYNGEAL NERVE is only distinguished within the scull as a larger filament of the eighth pair ; it is however distinct in its course from the origin to the point where it pierces the dura mater : it is the uppermost of the fibres of this pair of nerves.—Sometimes there is a very delicate filament running parallel with its lower edge which belongs to it. It has the same origin with the fibres of the par vagum.*

The PAR VAGUM is composed of ten or twelve very small filaments, which are sometimes united into three or four fasciculi. These filaments arise from the outer border of the corpus olivare, or from the lateral part of the medulla oblongata.† Sometimes they arise in a double series like the nerves of the spine : a few fibres are to be traced from the side of the calamus scriptorius of the fourth ventricle.

The SPINAL ACCESSORY NERVE comes up from the spine to join the par vagum ; it begins by small twigs from the posterior roots of the fourth, fifth, sixth, and even the seventh cervical nerves. In the size, length, and origin of those little slips, there is much variety : as the nerve ascends to the top of the spine, it connects itself with the suboccipital nerve ; it then passes behind the trunk of the vertebral artery, approaches the

* " Nervus gloſſo-pharyngeus faſciculo mox una, mox duabus, quatuor, quinque fibris compoſito oritur ex ſumma atque priore parte medullæ ſpinæ pone corpora olivaria nervum facialem inter atque nervum vagum, nonnunquam etiam ex quarto ventriculo vel ex cruribus cerebelli ad ſpinæ medullam, nonnunquam ſub poſteriori ſulco nervi vagi, deductus ab eo vel diſtinctius, vel obſcurius interpoſita arteria, vel vena, vel arteria et vena ſimul, vel parte plexus choreoidis, quid quod ipſa directione a nervo vago eſt diſtinctus." Soemmerring.

† Some filaments, according to Vieuſſens, Santorini, and Soemmering, are derived from the paries of the 4th ventricle.

par vagum, and receives some filaments from the medulla oblongata.—Those three nerves, the glosso-pharyngeal, par vagum, and accessory nerves, in their passage out of the scull are connected in a very intricate way.* They there separate from each other. The anterior branch, the glosso-pharyngeal nerve goes to the tongue and pharynx; the middle nerve, the par vagum, has an extensive course through the body, and finally terminates in the stomach; the lowest nerve, the accessory, passing into the neck, perforates the mastoid muscle, and distributes its branches amongst the muscles of the shoulder.

NINTH PAIR OF NERVES; OR, LINGUAL.

The ninth nerve of the scull originates from betwixt the corpora pyramidalia and olivaria. Like all the nerves of the spine, it is composed of several little filaments; those unite into a fasciculus of a pyramidal shape: still those filaments do not form a nerve before perforating the dura mater, but pierce it severally;† they then unite and pass out of the scull by the condyloid foramen of the occipital bone; they are then connected with the eighth pair and ganglion of the sympathetic nerve.—The final distribution of the nerve, is to the muscles of the tongue.‡

THE TENTH, OR SUBOCCIPITAL NERVE.

From its origin, its manner of passing betwixt the scull and first vertebræ, and its distribution, it must be classed with the nerves of the spine.

The nerves of the spine are divided into the eight cervical, twelve dorsal, five lumbar, five, and sometimes six or seven, sacral nerves.§ Each of those twenty-five nerves arises in two fasciculi, one from the fore, and the other from the back part of the spinal marrow. They are to be traced a great way in

* The minutiæ of which will afterwards call for attention.

† The ninth pair of nerves often differ very much in one fide from the other, in regard to the origin and number of thofe fafciculi.

‡ "Forfan etiam nimio fanguine plena arteria vertebrali preffus læditur, ut inde hæfitantia atque refolutio linguæ ebriorum, ex cerebri phlegmone infanientium, attonitorum explicari poffit.—Collapfa vero eadem arteria ex nimio fanguinis profluvio lingua ob fanguinis forfan defectum refolvitur.—Ex ejufdem nervi nexu cum nervis cervicalibus vocis jacturam poft læfam fpinalis medullæ partem quæ in cervice eft, explicarunt."

§ "Plerumque quinque funt, nonnunquam fex, raro tres vel quatuor." Soemmerring.

the length of the spinal marrow before they pass the membranes. The posterior and anterior fasciculi penetrate the dura mater separately, and afterwards unite. The posterior fasciculi of the dorsal nerve before they unite with the other, swell into a little ganglion. The posterior fasciculi of the cervical nerves communicate with each other by intermediate filaments.

END OF THE ANATOMY OF THE BRAIN.

CHAP. IV.

OF THE PARTICULAR NERVES.

THE FIRST PAIR OF NERVES; OR, OLFACTORY NERVES.

WE have described the three roots of this pair of nerves: their triangular form, their bulbous extremities, and their manner of perforating the crebriform plate of the æthmoid bone.

Where the soft and pulpy-like mass of the olfactory nerves perforates the æthmoid bone, the dura mater involves them, and gives them firm coats.* There are two sets of nerves; first, Those which pass through the holes in the cribriform plate, nearest the crista galli, run down upon the septum of the nose, under the schneiderian membrane, and betwixt it and the periosteum. They become extremely minute as they descend; and they, finally, pass into the soft substance of the membrane. Secondly, Those filaments which pass down by the outer set of holes of the æthmoid plate, are distributed to the membrane investing the spongy bones.

Although branches of the ophthalmic, pterigoid, palatine, and suborbital nerves pass to the membrane of the nose, there is reason to believe that they have no power of conveying the impression of odours. These nerves are necessary that the membrane may possess the common properties bestowed by the nerves.

Upon the question, whether those additional branches of nerves to the nose, assist in conveying the impression of odours, there has been much controversy. It is a subject upon which we might reason by analogy; but, certainly, little dependence can be placed upon those cases brought by either party, of diseases affecting the one set of nerves without influencing the other. From the nature of the parts, ulceration or tumors, which destroy the bones of the nose, must press equally upon the branches of the olfactory nerve, and of the fifth pair. We find that there pass also to the other organs of sense, subordi-

* Duverney firſt obſerved this courſe and firmneſs of the olfactory nerves.

nate nerves; and we know that a nerve may be modified to much variety of function; and this is evident from the nerve of taste being a branch of the fifth pair. But it is doubtful how far a nerve may be capable of receiving at one instant various impressions. Far from considering distinct nerves sent to the same organ, as affording an argument for these nerves receiving one uniform impression, and conveying one simple sensation, it would seem more rational to infer, that one individual nerve cannot perform two functions, and that two functions are often required in the organs of sense. I am inclined to believe, that the olfactory nerve is incapable of bestowing common sensation on the membrane of the nose; and that the other nerves which ramify on that membrane, do, on the other hand, contribute nothing to the sense of smell, as we find that the inflammation of the pituitary membrane, which raises the sensibility of the branches of the fifth pair of nerves, does in no degree make those of the olfactory nerve less acute. The membrane is painfully inflamed, but the sense of smell is deadened. In attending to the delicate sensibility of the nerves of the senses, we neglect to take into account the less prominent, but no less curious peculiarities in the sensations, and sympathies of the common nerves. The senses of taste or smell are not more distinct from each other, or from common sensation, than are the peculiar sensations which belong to the sensibility of the several viscera. The stomach and intestinal canal possess as great a discriminating power as the organ of taste, although the sensations are less perfectly conveyed to the sensorium. There is a variety in the susceptibility of the several organs and viscera, a distinct sensation and proportioned action and election which is essential to the order and œconomy of the general system. This is conspicuous in the variety of the affections in remote parts, when food, medicine, or poison is received into the body. These peculiarities in the impression of which each organ is susceptible, are so far distinct as to be essential to the due excitement of that organ; and are yet so general, as to connect, in one combined action, the whole system, and to occasion sympathies in remote parts, which perplex us, and give that degree of intricacy to the living actions, which renders medicine an uncertain art.

ARRANGEMENT OF THE NERVES PROCEEDING FROM THE CRANIUM.

The first nerve we have seen passing to the nose.

The second, third, fourth, part of the fifth and sixth, pass to the eye, or through the orbit.

The seventh nerve is that which becomes the organ of hearing.

Part of the fifth, seventh, eighth, ninth, and suboccipital nerves pass to the bones of the face, the integuments and muscles of the face, the jaw, and throat.

From the sixth pair of nerves is derived the great sympathetic ; from the eighth is sent downwards the par vagum.

The extreme branches of the fifth pair, of the seventh, of the eighth, ninth, and first cervical nerves, form a chain of connections, surrounding the head, face, and neck.

SECOND PAIR, OR OPTIC NERVES.

In this part of the work there is no occasion to deliver any thing further concerning the optic nerves, than has been already said of their origin, and final expansion in the retina of the eye. It will be more proper to consider them fully when treating of the eye in particular.

THIRD PAIR OF NERVES, OR MOTORES OCULORUM.

These nerves have the name of motores oculorum, because they are distributed to the muscles which move the eye-balls. They pass upwards from their origin; and then diverging, they penetrate the dura mater under the extreme point of the tentorium ; they descend again by the side of the cavernous sinus, and pass out of the cranium by the foramen lacerum of the sphenoid bone.

The nervus motor oculi having come into the socket divides into two branches : the INFERIOR BRANCH passes forward along the outside of the optic nerve ; it then divides into these branches :

1. To the adductor muscle.
2. To the rectus inferior.
3. To the external oblique and to the lenticular ganglion.

But the branch of the third nerve, which, with the fifth, forms this little ganglion, is, by no means, constantly derived from this branch. The LESSER and SUPERIOR BRANCH of the third, is distributed to the rectus superior oculi and levator palpebræ superioris.

FOURTH PAIR OF NERVES, TROCHLEARES, OR PATHETICI.

These nerves are very small. Their origin, from about the tubercula quadrigemina, and their long course under the base of the brain, have been already described ; after proceeding a

considerable way, incased in the duplicature of the dura mater, where it forms the extreme point of the tentorium, they pass amongst the lamellæ of the dura mater, where it forms the cavernous sinus. They pass by the outside of the third pair of nerves; turn round so as to be above them, and make their egress through the foramen lacerum of the sphenoid bone.—They pass forward in the orbit, undiminished by the giving off of branches; and arc each finally distributed to the superior oblique muscle or trochlearis. Sometimes, however, in their course, they send branches to unite with those of the fifth pair, which pass to the nose, or even to the frontal nerve; but this is very rare.*

As this nerve is derived very far back from the brain, and as the parts from which it originates are less affected by the distention of the ventricles than almost any other part of the brain, this may be a reason why in hydrocephalus we so frequently see the eyes turned obliquely towards the nose. The origins of these nerves being less affected, they will give a comparatively greater power to the superior oblique muscle. It has been observed also, that in death the power of the superior oblique muscle has a preponderance.

THE FIFTH PAIR, OR TRIGEMINI.

The tracing of the branches of the fifth pair, by dissection, is a difficult task, for those branches are distributed among the bones of the face, to the eyes, nose, mouth, tongue, and throat. From this extensive distribution the fifth nerve is necessarily the largest of those that pass out of the cranium.

It is of a flattened form;† it penetrates the dura mater at the anterior point of the petrous bone, and spreads flat under it. Here, under the dura mater, it is matted into one irregular ganglion; *viz.* the semilunar, or Gasserian ganglion. This ganglion lies on the anterior point of the temporal, and on the sphenoidal bone. In their passage from the brain, the filaments, composing the fifth nerve, are loose, or easily separated; at this place, they are all found so subdivided and entangled, as to resist further division. The nerve here swells out into a greater size; it seems to be incorporated with the dense fibres of the dura mater; it becomes of a dark red, or mixed colour; all which circumstances have, by no means, been unobserved by anatomists. Vieussens supposed, that the use of this ganglion, of the fifth pair, before it perforates the cranium, was to strengthen the nerve, and enable it to withstand the motion of

* Soemmerring.

† So it is said, by Mickel, to resemble the flat worm, or tænia.

the jaws! But it would rather seem to be a ganglion connecting in sympathy all those parts to which the nerve is finally distributed*.

The connection of the Gasserian ganglion with the dura mater, is so firm, that it yet remains undecided, whether there are sent off here any nerves to that membrane; but I conceive, that there are none, and that the connection of the ganglion with the fibrous membrane, or sheath which covers it, has been mistaken for nerves passing from the ganglion to the dura mater.

From the semilunar or Gasserian ganglion, the fifth nerve divides into three great branches; whence the name of trigemini:

1st, The OPHTHALMIC BRANCH of WILLIS, which passes through the foramen lacerum into the orbit.

2d, The SUPERIOR MAXILLARY NERVE, which passes through the foramen rotundum.

3d, The INFERIOR MAXILLARY NERVE, which passes to the lower jaw, through the foramen ovale.

The ophthalmic branch of the fifth pair.

This nerve enters the orbit in three divisions; these are, the *frontal*, the *nasal*, and the *lachrymal* nerves.

1st, The first of these runs under the periosteum of the upper part of the orbit, and above the levator palpebræ superioris. Upon entering the orbit it gives off a small branch, which passes to the frontal sinus; the nerve then divides into the super trochlearis, and the proper frontal nerve. The first of these passes to the inner part of the orbicularis oculi and frontal muscle. The other, the outermost, and the proper frontal nerve, passes through the hole, or notch, in the margin of the orbit, and mounts upon the muscles and integuments of the forehead. These superficial branches communicate with the extreme branches of the portio dura, or nervus communicans faciei.

Cases are on record of wounds of the frontal nerve occasioning a great variety of nervous symptoms, and especially loss of sight; and it certainly marks a very particular connection and sympathy betwixt this branch and the common nerves which pass to the eye-ball and iris, and the retina, that blindness is actually occasioned by the pricking of the frontal nerve.—Morgagni supposes this to be occasioned by the spasmodic

* "Et affectum animi indicia in faciei partibus depingere adjuvet." Hirsch. Sand. Thes. Diserta, p. 491.

action of the recti muscles pressing the globe of the eye down against the optic nerve. It is also remarkable, that impressions acting solely on the retina, will convulse the muscles of the eye, give them irregular contractions, and consequently distort the eye-ball and produce blindness. Such has been found to be the effect of lightning in some instances.

2d, The NASAL BRANCH of the ophthalmic nerve sends off a slip or twig to form with a branch of the third pair, the LENTICULAR OF OPHTHALMIC GANGLION; while the trunk of the nerve passes obliquely forwards, and inward through the orbit, and gives off one or two extremely small twigs, which join the fasciculi of ciliary nerves. The nasal branch then continues its course betwixt the superior oblique and adductor muscles; before piercing the orbital plate, it sends forward a branch, which passing under the pulley of the superior oblique muscle, joins that division of the frontal nerve which passes over the pulley. The nasal nerve then passing through the internal orbital foramen, enters the scull again, and runs under the dura mater, which covers the æthmoid bone, to pass through the cribriform plate of that bone, and again to escape from the cranium. It is finally distributed to the upper spongy bones, and to the frontal sinuses.

We thus observe such a connection of the nerves of the eye and nose, and of those distributed to the inner angle of the eye, and muscles of the eye-lids, as sufficiently accounts for the sympathy existing among those parts. We see the necessity of this connection, since the excitement of the glands which secrete the tears, the action of the muscles, and the absorption of the tears into the nose, must constitute one sympathetic action.

The LENTICULAR, or, OPHTHALMIC GANGLION, comes naturally to be considered under this division of the fifth pair. The lenticular ganglion is formed by a twig from the nasal branch of the fifth pair, after being united to that branch of the third pair of nerves, which goes to the levator palpebræ and the rectus superior muscles. The ganglion is of a square form, and is situated upon the outside of the optic nerve. The ciliary nerves pass out from this ganglion into two fasciculi; they are ten or twelve in number; they are joined by branches of the continued nasal nerve. The ciliary nerves run forward amongst the fat of the orbit, to the sclerotic coat of the eye, and pierce it very obliquely in conjunction with the ciliary arteries. The ciliary nerves and arteries then pass forward betwixt the sclerotic and choroid coats of the eye to the iris. The iris is considered as the part the most plentifully supplied with nerves (as it certainly is also with arteries) of any

part in the body. It follows, indeed, from what we formerly said, that a profuse circulation of blood is necessary to an accumulated nervous power.

From the connection of these ciliary nerves with those passing to the nose, Soemmerring accounts for sneezing being the consequence of a strong light upon the eye. This may perhaps be true; but, certainly, the temporary loss of light, from sneezing, does not depend upon this connection of the nerves, but upon the immediate affection of the optic nerve and retina, from the concussion and interruption to the circulation, or upon the accumulation of blood in the eye.

2. The LACHRYMAL NERVE is the least of the three divisions of the ophthalmic nerve; it divides into several branches before it enters the gland. Several of these branches pass on to the tunica conjunctiva, being joined by twigs of the first branch of the superior maxillary nerve. Others connect themselves with the extremities of the portio dura of the seventh pair, and with the superior maxillary nerves.

The second branch of the fifth pair; viz. *the superior maxillary nerve.*

The superior maxillary nerve, having passed the foramen rotundum, emerges behind the antrum highmorianum, at the back part of the orbit, at the root of the pterigoid process of the sphenoid bone. The infra orbital canal lies directly opposite, and ready to receive one branch, while the spheno-maxillary, opening into the orbit, is above, ready to receive another. The chief part, or trunk, of the nerve may be said to be seated, and to give out its divisions in the pterigo-palatine fossa. Through the spheno-maxillary hole, the first branch of the superior nerve is sent into the socket of the eye. This twig unites with branches of the lachrymal nerve, and in general supplies the periosteum of the orbit. It then sends, through the foramen in the os mallæ, a branch which is distributed to the orbicularis muscle of the eye-lid, and communicates with the branches of the portio dura of the seventh pair, or nervus communicans faciei. Another branch of this first division passes upwards from the zygomatic fossa, in a groove of the wing of the sphenoid bone, to the temporal muscle, and getting superficial, it accompanies the branches of the temporal artery.

Independently of this branch, which passes upwards to the temporal muscle, Miekel, in his first dissertation on this nerve, divides its branches into four: 1st, The infra orbital; 2d, The descending branch, which again gives off the vidian

and nasal nerves; 3d, The palatine nerve and posterior alveolar nerve. It was not till afterwards that he discovered the ganglion which takes his name; and, of course, the previous description must be imperfect. The superior maxillary nerve, after sending off the small branches which I have described to enter the orbit, having fairly emerged out of the cranium, sends down two small branches which, uniting, form a little ganglion of a reddish colour, and of a triangular shape, like a heart. This, the SPHENO-PALATINE GANGLION, or ganglion of Miekel, is exactly opposite to the spheno-palatine hole; and those nerves, and this ganglion are immersed in the soft fat which fills up the space betwixt the sphenoid palatine and superior maxillary bones.

From this ganglion are sent out several lesser nerves, and particularly the nasal, vidian, and palatine nerves.

The SUPERIOR NASAL BRANCHES pass by the spheno-palatine hole to the membrane on the back part of the nose, and to the cells of the sphenoid bone, through the spheno-palatine hole.

The VIDIAN NERVE comes off from the back part of the ganglion, and passes into the foramen pterigoideum backwards. It first gives off some small branches to the nose (the superior and posterior nasal nerves of Miekel); these perforating the bone laterally, are distributed on the pituitary membrane, covering the vomer. The vidian nerve continuing its course backwards, splits; one branch, after a long retrograde course through the petrous part of the temporal bone, forms a connection with the portio dura, while the other forms one of the roots of the great sympathetic nerve, by joining the branch of the sixth pair, which passes down with the carotid artery.

From the distribution of this branch of the fifth pair to the membrane of the nose, and its connection with the sympathetic, some physiologists account for the effects of odours in causing fainting, as the chief nerves of the heart are received from the sympathetic. They also account thus for the excitement of the heart, in deliquium, by stimulant applications to the nose.

The PALATINE NERVE is the largest of the branches sent out from the ganglion. We have to recollect, that there are two canals passing down behind the palate; one anterior and larger; and another running nearly parallel to it, a posterior and smaller one. The division of the palatine nerve, which descends through the anterior palatine hole, is of course the larger branch; as it passes through the canal, it gives branches which enter the nose, to be distributed upon the pituitary membrane. This larger branch, in its further progress

through the bone, divides, and having emerged from its hole, is distributed all along on the left palate. The posterior division of the palatine branch, passing down by the posterior palatine foramen, is distributed to the velum pendulum palati and its muscles.

There is yet a third branch of the palatine nerve; *viz.* the external palatine nerve. It is the least of all the branches; and, sometimes, instead of coming from the ganglion, is derived immediately from the superior maxillary nerve. This branch descends before the pterigoid processes, and on the convex surface of the upper maxillary bone, and is distributed to the velum palati and uvula.

The superior maxillary nerve, after sending off the branches which form the spheno-palatine ganglion, passes obliquely downwards to the infra orbital canal. In this course it gives off the posterior nerve to the teeth of the upper jaw; and this again gives off a twig, which takes a course on the outside of the maxillary bone, and supplies the gums and alveoli, and buccinator muscle.

While passing in its canal, the infra orbital nerve gives off the anterior nerve to the teeth; and when it emerges from the infra orbital foramen, it spreads widely to the muscles of the face, connecting itself with the extremities of the portio dura of the seventh pair, or nervus communicans faciei.

The "tic douloureux," and the "tic convulsif," of the French authors, are diseases attributed to the affection of this nerve. The seat of the tic douloureux, is the side of the face, the nostril, the cheek-bone, and root of the alveoli. Sauvage calls it the trismus dolorificus, or maxillaris. But it is a disease not absolutely fixed to this point of the cheek-bone; but on the contrary, from the universal connection betwixt the nerves of the face, it takes, sometimes, a wide range; and the disease, I have no doubt, is sometimes seated in the portio dura of the seventh pair. Sauvage has given to one species of it, the name of occipitalis.

It is a disease attended with extreme pain, which forces the patient to cry out in great agony. The pain is felt deep rooted in the bones of the face, and seems to spread upon the expanded extremities of the nerve; it is sudden, violent, and reiterated in its attack, and it varies in the length and repetition of its accession. It is confined chiefly to those advanced in years, and is as violent in the day as during the night; and in the advanced state of the disease, when the face is swelled, the slightest touch will excite the pain.

This disease is apt to be confounded with the affection of the antrum highmorianum, the tooth-ach, rheumatism, and clavis

hystericus, or even with venereal pains. It has been cured by dividing the infra orbital nerve.

In hemicrania, the affection of the three branches of the fifth nerve, is such as to mark their distributions. There is swelling and pain of the face, pain of the upper maxillary bone, pains in the ear and in the teeth, difficulty of swallowing, and lastly, stiffness in moving the lower jaw, in consequence of the affection of those branches which pass up to the temporal muscle.

There are cases spoken of by Sabbatier, where this infra orbital nerve being wounded, unusual nervous affections, and even death, were the consequence : but it would rather appear, that, independently altogether of the affection of the nerves of the face, inflammation spreading from the wound to the brain, had, in the examples which he gives, been the occasion of the unusual symptoms, and of the death of the patients.

Third branch of the fifth pair ; or, lower maxillary nerve.

This, the last of the three great divisions of the fifth pair of nerves, the largest but the shortest branch within the scull, passes out by the foramen ovale. It is distributed to the muscles of the lower jaw, tongue, and glands. The trunk of the nerve having escaped from the cranium, lies covered by the external pterigoid muscle ; and is at this point divided into two great branches, which again subdivide into numerous small branches ; many of which it would be superfluous to describe. It is sufficient to mention them as going, 1, to the masseter muscle ; 2, to the zygomatic fossa and temporal muscles ; 3, to the buccinator muscle.

We regard as the two greater divisions of the lower maxillary nerve ; first, The proper nerve which passes into the lower jaw ; and, secondly, The gustatory or lingual nerve. The division into these two great branches is formed, after the nerve has passed betwixt the pterigoid muscles.

The GUSTATORY NERVE, immediately after its separation from the nerve of the lower jaw, is joined by the chorda tympani ; or, perhaps we should rather say, a branch of this nerve, by traversing the petrous portion of the temporal bone in a retrograde direction, unites itself with the portio dura of the seventh pair, as it is passing through the ear. This nerve being seen passing across the tympanum, is the reason of its being called, CHORDA TYMPANI. The gustatory nerve, proceeding obliquely downward, sends off twigs to the salivary glands and muscles, situated betwixt the jaw-bone and tongue.—Where it is passing by the side of the maxillary gland, it gives

out some filaments which form a small ganglion, from which branches penetrate the gland. The trunk then proceeding onward betwixt the sublingual gland and the musculus hyoglossus, several twigs are sent off, which form a kind of plexus amongst the muscles and salivary glands; and communicating with the ninth pair of nerves, are distributed, finally, to the gums and membrane of the mouth.

The gustatory nerve terminates in a lash of nerves, which sink deep into the substance of the tongue, betwixt the insertion of the stylo and genio-glossal muscles. These pass to the papillæ on the surface of the tongue. The sense of taste, the impression of which is received upon this nerve, is seated in the edge and anterior part of the tongue: the action of the tongue against the palate forces the sapid juice of the morsel to extend to the edge of the tongue.

The proper lower maxillary nerve, which enters into the lower jaw-bone, sometimes called, *mundibulo labralis*, passes downward in an oblique direction to the groove of the lower jaw-bone. Before this nerve enters the canal of the bone, it gives off branches to the mylo-hyoideus and digastricus, to the submaxillary glands and to the fat. The nerve then entering the bone, runs its course all the length of the lower jaw within the bone, and comes out at the mental hole. In this course it gives branches which enter the roots of the teeth, and accompany the branches of the arteries. When this lower maxillary nerve has escaped from the mental hole, it divides into two branches upon the chin; one of these is distributed to the orbicularis and depressor anguli oris, and to the skin and glands of the lips; the other to the depressor labii inferioris and integuments, and forms a kind of plexus, which surrounds the lips. These nerves are also connected with the wide spreading branches of the portio dura of the seventh pair; and they are the lowest branches of the facial nerves, and the last enumerated of the intricate branches of the fifth pair.

THE SIXTH PAIR OF NERVES; ABDUCENTES, OR MOTORES EXTERNI.

The sixth pair of nerves, as we have seen, arises betwixt the tuber annulare and the corpus pyramidale. Advancing forwards and upwards, sometimes above and sometimes beneath the branches of the basilar artery, it penetrates the dura mater by the side of the basilar sinuses. It then passes by the side of the carotid artery, and through the cavernous sinus.—Here it gives off filaments, which, clinging to the carotid artery, descend with it until they are joined by a branch of the

vidian nerve. These together form the origin of the great sympathetic nerve. It is a disputed point, however, whether this be a branch given out from, or received into, the sixth pair; and in the description of the sixth pair, we might say, that as it passes the carotid artery, it receives one or more nerves which come up through the carotid hole, and encircle the nerve. The sixth pair enters the orbit by the foramen lacerum, with the third and fourth pairs, and first branch of the fifth. It pierces the abductor muscle of the eye before it is finally distributed to its substance.

It has been presumed, that the sixth nerve does not give off the sympathetic nerve, but receives those branches from it, because the sixth nerve is larger betwixt this point and its distribution in the orbit, than betwixt the same point and its origin from the brain. But I conceive, that this enlargement of the sixth pair is not owing to such a junction; but that, on the contrary, the nerve naturally swells out when it enters the sinus, not from being soaked in the blood of the sinus, but from its having additional investing coats, or from the coats being strengthened in order to prepare the nerve for its passage through the blood of the sinus.

Again, that the sympathetic nerve sends up those branches to join the sixth, has been presumed from the effects of experiments on animals, of cutting or of bruising the sympathetic nerve. But I should not be apt to give implicit credit to the result of these experiments. Supposing that the sympathetic in the neck gave an origin to the sixth pair, should not paralysis of the abductor muscle of the eye, and in consequence of this, the turning of the eye towards the nose, be the effect of cutting the sympathetic?

We shall probably cease to dispute this point, when we consider the relations and use of the sympathetic nerve.

The nerves cannot be considered in any other light than as being formed of the same matter with the brain, as having similar functions and powers, rather co-existing than dependant on the brain: and the sympathetic nerve may be defined, a tract of medullary matter, passing through and connecting the head and neck, the viscera of the thorax, abdomen, and pelvis, into one whole.

The sympathetic nerve is singular in this, that it takes no particular origin, but has innumerable origins, and a universal connection with the other nerves through all the trunk of the body. Those viscera to which it is distributed are entirely independent of the will, and have functions to perform too essential to life to be left under the influence of the will. The sympathetic nerve is thus, as it were, a system within itself, having

operations to perform of which the mind is never conscious; whilst the extent of its connections occasion, during disease, sympathetic affections not easily scrutinized.

The function of this nerve is thus, in a great measure, insulated from the brain. The operations connected with it proceed, even when the brain is wanting; and it is impossible seriously to consider the sixth nerve as giving the origin to the sympathetic in any other light, than as such an expression may be subservient to arrangement, description, and general enumeration of the nerves;—a thing most necessary in so intricate a piece of anatomy.

OF THE SEVENTH PAIR OF NERVES.

The nerves of the seventh pair consist each of two fasciculi, which arise together, and pass into the foramen auditorius internus.* But these portions do not pass through the bone in union; for the anterior and lesser fasciculus, is a common nerve, which passes through to the face, and is invested, like the common nerves of the body, with strong coats. It is therefore called the PORTIO DURA.† The more posterior fasciculus is the auditory nerve, and is distributed to the organ within the pars petrosa of the temporal bone; and in distinction it is called the PORTIO MOLLIS.

The PORTIO DURA, or NERVUS COMMUNICANS FACIEI, in passing from the brain to the internal auditory foramen, is lodged in the fore part of the auditory nerve, as in a groove.—When it leaves the auditory nerve, it passes on through the bone, and emerges on the side of the face through the stylomastoid foramen at the root of the styloid process, so as to come out just under the tip of the ear, covered, of course, by the parotid gland. The portio dura, while passing through the canal of the temporal bone (which is the aqueduct of Fallopius,) gives off a branch which unites with the vidian nerve of the fifth pair; or rather, we may conclude with the best authors, that it receives a branch which comes retrograde from the vidian nerve, passing through the small hole on the anterior surface of the petrous part of the temporal bone. The portio dura, when it has proceeded onwards by the side of the tympanum, gives off one or more very minute branches to the

* The intermediate filaments of Wriſberg, which is betwixt theſe two portions of the ſeventh nerve, is afterwards united to the portio dura, and muſt be conſidered as one of its roots.

† Galen divided all the nerves of the brain into thoſe two claſſes, *mollis* and *dura*; of which the firſt were thoſe of the ſenſes, the latter the motores corporis.

muscles within the tympanum, which give tension to the small bones of the ear. A little further on, this nerve gives off a more remarkable branch, which, passing across the tympanum, is called CORDA TYMPANI. This is the branch which, as we formerly mentioned, joins the gustatory branch of the lower maxillary nerve. The corda tympani passes through the tympanum betwixt the long process of the incus and the handle of the malleus ; then, received into a groove of the bone, it passes by the side of the eustachian tube, and after enlarging considerably, it is united with the gustatory nerve.

When the portio dura, or nervus communicans faciei, has escaped from the stylo-mastoid foramen, but is yet behind the condyle of the lower jaw, and under the parotid gland, it gives off, 1st, The posterior auris. This has connection with the first cervical nerve, and passing up behind the ear, it is connected with the occipital branches of the third cervical nerve. 2d, The nervus stylo-hyoideus to the styloid muscles, and to unite with the sympathetic. 3d, A branch which supplies some of the deep muscles, and joins the laryngeal branch of the eighth pair.

The portio dura, rising through the parotid gland, spreads out in three great divisions:

1. An ASCENDING BRANCH, which divides into three temporal or jugal nerves ; so called, because they ascend upon the jugum, or zygomatic process. Two orbitary nerves, which, passing up to the orbicularis muscle, branch upon it, and inosculate with the extremities of the fifth pair.

2. The FACIAL NERVES. The superior facial nerve passes out from the upper part of the parotid gland, across the face to the cheek and orbicularis muscle of the eye. The middle facial nerve passes from under the risorius santorini ; it goes under the zygomatic muscle, and encircles the facial vein ; it sends branches forward to the lips, and upwards to the eyelids, and to unite with the infra-orbital nerve. There is an inferior facial nerve, which comes out from the lower part of the parotid gland, passes over the angle of the jaw, and is distributed to those fibres of the platysma myoides which stretch up upon the face, and form the risorius santorini : it passes on to the angle of the lips, and is distributed to their depressor muscle. Betwixt those facial nerves there are frequent communications, while they are at the same time united with the extremities of several branches of the fifth pair.

3. The DESCENDING BRANCHES pass along the margin of the jaw, down upon the neck, and backward upon the occiput. Thus we see that the communicating nerve of the face is well named.—It is distributed to the side of the face, head, and up-

per part of the neck: it unites its extreme branches with those of the three great divisions of the fifth pair, with the eighth and ninth, with the accessory of the eighth pair, with the second and third cervical nerves, and with the sympathetic. From those various connections it has been called the lesser sympathetic. As to the sympathies which physicians have thought fit to ascribe to the connections of this with other nerves, as laughing, weeping, kissing, &c. they would be tedious to enumerate, and by no means instructive.

The PORTIO MOLLIS of the seventh pair of nerves is the acoustic or auditory nerve; which shall be considered in a more distinct and particular manner, when we describe the other parts of the organ of hearing.

The nerves which we have now described are connected with the anatomy of the head, and circulate chiefly around the bones of the face. Those we are next to consider extend their branches to the neck, and form there a very intricate piece of anatomy, while a class of them still more important, pass down to the viscera of the breast and belly.

THE EIGHTH PAIR OF NERVES.

THE fasciculus, which, proceeding from the medulla oblongata, passes out of the cranium by the side of the great lateral sinus, and which, in the view we have of the nerves upon raising the brain from the cranium, is properly enough considered as the eighth pair, consists in truth of three distinct nerves. These are the GLOSSO-PHARYNGEAL NERVE, the PAR VAGUM, and the SPINAL ACCESSORY NERVE of WILLIS.

THE GLOSSO-PHARYNGEAL NERVE.

This nerve, parting from its connection with the par vagum and accessory nerves, perforates the dura mater separately from these, and in many subjects, passes through an osseous canal distinct from the par vagum. When it escapes from the cranium, it lies deep under the angle of the jaw, and passes across the internal carotid artery upon its outer side. It is to be seen by lifting the styloid muscles, at which point it sends small branches to the styloid and digastric muscles, and to join the par vagum. It sends also some very small twigs down upon the internal carotid artery; some of which join

that pharyngeal branch* which is formed from the par vagum and accessory nerve.

These branches united form a small irregular ganglion, from which again pass off numerous branches to the constrictor muscles of the pharynx.

The trunk of the glosso-pharyngeal nerve, after giving off those nerves which pass in the direction of the internal carotid artery, continues its course attached to the stylo-glossal and stylo-pharyngeal muscles, to which of course it gives more branches, and also to the upper division of the constrictor pharyngis. A division of the extreme branches of this nerve terminates in the tongue, under the denomination of *rami linguales profundi*, *rami linguales laterales*, *nervi glosso-pharyngei*†.

It appears to me that these branches are distributed amongst the short muscles of the tongue, and perhaps to the large papillæ upon the most posterior part of the tongue. Amongst the branches of the pharyngeal nerve is to be enumerated that which turns back to join the ninth pair in its distribution to the tongue‡. The remaining branches of the glosso-pharyngeal nerve, are distributed in innumerable filaments upon the pharynx, in which they are assisted by branches from the ganglion of the sympathetic nerve.

THE PAR VAGUM.

The par vagum is the great and important division of the eighth pair. It is the middle fasciculus of the three nerves as they lie within the scull. In its exit, it is separated from the internal jugular vein by a thin bony plate ; and sometimes two or three fibres of the nerve pass the bone distinct from the others, and afterwards unite into the proper trunk of the par vagum. Deep under the lower jaw and the mastoid process, the glosso-pharyngeal nerve, the par vagum, the spinal accessory, the sympathetic nerve, the portio dura of the seventh, and the upper cervical nerves, are entangled in a way which will fatigue the dissector, and may account for every degree of sympathy of parts. The par vagum, lying behind the internal carotid artery, and as it were escaping from the confusion

* This is a branch to the pharynx which is formed by the par vagum and the spinal accessory of Willis. After this nerve is formed, it again forms connection with the par vagum.—Pain in the throat having been observed by Galen to extend to the back, Scarpa explains it on the ground of this connection with the spinal accessory nerve.

† Scarpa.

‡ Sabbatier.

of the ninth accessory and glosso-pharyngeal nerves, descends and swells out into a kind of ganglion.* We now observe three branches to be sent off: The FIRST and SECOND PHARYNGEAL NERVES, which pass to the constrictor pharyngis muscle, and the INTERNAL LARYNGEAL NERVE. This last mentioned nerve is even larger than the glosso-pharyngeal nerve. It is behind the carotid artery, and passes obliquely downward and forward. In its progress the principal branch passes under the hyo-thyroideus muscle, and betwixt the os hyoides and the thyroid cartilage; while others, more superficial, pass down and are connected with the EXTERNAL LARYNGEAL, or PHARYNGO-LARYNGEUS; which is a nerve formed by the sympathetic, and par vagum conjointly. The principal branch of the internal laryngeal nerve, which runs under the hyo-thyroideus, is distributed to the small muscles moving the cartilages. The minute extremities of this nerve pass also to the apex of the epyglottis, and the glandular membrane covering the glottis. We have, at the same time, to remark a very particular communicating nerve betwixt this internal laryngeal nerve, and the recurrent branch of the par vagum. This branch is described by Galen. The par vagum continues its uninterrupted course betwixt the carotid artery and jugular vein, and is involved in the same sheath with these vessels. In this course down the neck, it sometimes sends back a twig which unites with the ninth pair, and when near the lower part of the neck, it sends forward twigs to unite with those from the sympathetic nerve, which pass down to the great vessels of the heart, to form the superior cardiac plexus.† On the right side, those nerves to the great vessels are in general given off by the recurrent nerve.

The par vagum now penetrates into the thorax by passing before the subclavian artery; it then splits into two. The main nerve passes on by the side of the trachea, and behind the root of the lungs; while the branch, on the right side, turns round under the subclavian artery; on the left, under the arch of the aorta, and ascends behind the trachea to the larynx.

This ascending branch of the par vagum is the RECURRENT NERVE. On the right side it is sometimes double. It ascends behind the carotid artery, and sometimes is thrown round the root of the thyroid artery. On the left side, which, from its turning round the arch of the aorta, is much lower than on the

* *Truncus gangliformis* OCTAVI, *tumidulum corpus olivare*, Fallopii; but it is ſuſpected that in this he meant the ganglion of the ſympathetic nerve.

† The courſe of theſe nerves to the heart, is beſt treated of with the branches of the ſympathetic nerve.

right, it gives off filaments which go to the lower cardiac plexus, after having united with the branches of the sympathetic. Under the subclavian of the right side, also, there are sent branches from the recurrent to the cardiac plexus: and on both sides there pass branches of communication betwixt the sympathetic nerve and the recurrent. When the recurrent nerve has turned round the artery, it ascends in a direction to get behind the trachea, and it lies betwixt the trachea and œsophagus. It here sends off many branches to the back and membranous part of the trachea which pierce this posterior part, to supply the internal membrane. It gives also branches to the œsophagus and thyroid gland. The final distribution of this nerve is to the larynx. It pierces betwixt the thyroid and cricoid cartilages, and separates into many filaments, which terminate in the crico-arytenoideus lateralis and posticus, and thyro-arytenoideus, and in the membrane of the larynx. We have already mentioned the branch of communication betwixt the recurrent and internal laryngeal nerves,* and Sabbatier describes a branch of the recurrent, which sometimes ascends and joins the sympathetic high in the neck.

Two cases, mentioned by Galen, of scrophulous tumours in the neck opened, where the consequence was loss of voice, have tempted many anatomists to institute experiments on the recurrent and internal laryngeal nerves.† Notwithstanding the deep situation of those recurrent nerves, Galen says, they were cut in these cases, and he believed that the branch of communication betwixt the laryngeal and recurrent restored the voice after some time had elapsed. Both the internal laryngeal and recurrent nerves are necessary to the formation of the voice. Experiments have been made upon them in dogs, and the result is curious; although the lesser changes of the strength, acuteness, and modulation of the voice could not be well observed in the lower animals. When the laryngeal nerve is cut, the voice is feeble but acute; when the recurrent nerve is cut, there is a relaxation of those muscles moving the arytenoid cartilages which command the opening of the glottis, and in consequence the voice is flatter or graver, or more raucous.

The par vagum, after sending off the recurrent nerve, descends by the side of the trachea. Before it passes behind the

* There is a double communication betwixt those nerves; in the first place by this more superficial branch, and again by several internal and more minute branches.

† Martin, in the Edinburgh Essays, Professor Sue of Paris, Dr. Highton, in the memoirs of the Medical Society of London; Cruikshanks, Professor Scarpa, Arnemann, &c.

vessels and branch of the trachea going to the lungs, it sends minute branches which form the ANTERIOR PULMONIC PLEXUS.* This plexus is entangled in the connections of the pericardium, and is dissected with difficulty. The branches of this plexus throw themselves round the pulmonic arteries and veins, and follow them into the lungs.

The par vagum, passing on behind the root of the lungs, forms the POSTERIOR PULMONIC PLEXUS. From this also the nerves proceed into the lungs, by attaching themselves to the pulmonic arteries and veins, and bronchial arteries, and the branches of the trachea.†

The trunks of the nerve, continuing their course upon each side of the œsophagus, unite and split into branches, and again unite so as to form a netting upon the œsophagus; these are the ANTERIOR and POSTERIOR PLEXUS GULÆ, or ŒSOPHAGEAL PLEXUS. The par vagum, thus attached to the œsophagus, pierces the diaphragm with it, the anterior plexus unites again into a considerable trunk, is attached to the lesser arch of the stomach. It stretches even to the pylorus, and sends its branches to the upper side of the stomach and to the lesser omentum; at the same time it unites with the left hepatic plexus, some of its branches terminate in the solar plexus, which surrounds the root of the cæliac artery. The posterior œsophageal plexus, likewise uniting again into a considerable cord when it has come into the abdomen, sends branches to encircle the cardiac orifice of the stomach; it branches also to the inferior side and great arch of the stomach; it sends also branches to the splenic plexus and solar ganglion.

* I do not conceive that this plexus admits of any uſeful diviſion, or requires any diſtinction of name.

† *Nerves of the Lungs.*

Galen, Veſalius, and others, conceived that there were very few nerves ſent to the lungs, and that thoſe which were, went only to the membranes, and not to the ſubſtance of the lungs. They believed alſo that the diſcharge of blood from the lungs and the exiſtence of vomicæ without pain, while there was great pain in peripneumony, was a confirmation of this opinion. Fallopius corrected this idea, and ſhowed that the bronchiæ were alſo attended through their courſe with nerves. There often exiſts vomicæ and effuſions of blood in the lungs; and Haller ſays, the lungs can be lanced without the animal feeling pain, but ſtill the bronchiæ are extremely ſenſible.—Water accumulated in the interlobular cellular membrane, or the infarction of blood into it, gives no acute pain, but only a ſenſe of weight and difficulty of breathing. It is an oppreſſion in a great meaſure depending upon the return of the blood from the lungs, unchanged in conſequence of the compreſſion of the cells.—The ſenſibility of the bronchiæ, and the exiſtence of their nerves, appear in aſthma; and alſo from the pain excited by calculi, and from their irritability excited by recent ulceration, or when vomicæ are diſcharged into them.

The connection betwixt the ſtomach and bronchiæ, through the medium of the par vagum and pulmonic plexus, is evident from thoſe aſthmatic attacks which depend upon foulneſs in the ſtomach.

Thus we see that the par vagum has a most appropriate name, and that it is nearly as extensive in its connections as the sympathetic itself. It is distributed "to the œsophagus, pharynx, and larynx; to the thyroid gland, vessels of the neck and heart, to the lungs, liver and spleen, stomach, duodenum, and sometimes to the diaphragm." The recollection of this distribution will explain to us many sympathies; for example, the hysterical affection of the throat when the stomach is distended with flatus, the exciting of vomiting by tickling the throat, the effect which vomiting has in diminishing the sense of suffocation, that state of the stomach which is found upon dissection to accompany hydrophobia, whether spontaneous, or from the bite of a dog.

OF THE ACCESSORY NERVE, OF THIRD DIVISION OF THE EIGHTH PAIR OF NERVES.

The spinal accessory nerve of Willis, is that which, taking its origins like the cervical nerves from the spinal marrow, ascends through the spine and foramen magnum of the occipital bone, and passes again from the scull like one of the nerves of the brain. It passes out with the par vagum, is attached to it in its passage, but again separates from it when it has escaped from the scull. Under the base of the cranium it is attached to the ninth pair also. Commonly this attachment is firm; sometimes, it is by a short filament. This parasitical nerve then passes behind the internal jugular vein, and passes obliquely downward and backward. It then perforates the mastoid muscle, and passes in a direction across the neck to the shoulder. While it pierces, it gives nerves to the mastoid muscle; and after piercing, it entangles its branches with those of the third and fourth cervical nerves. It then passes under the trapezius muscle, and is distributed to it, where it is on the back of the neck and shoulder. From the distribution of this nerve we discover that the shrug of the shoulders is very natural; and "pourquoi les grandes passions de l'ame nous portent à gesticuler, pour ainsi dire, malgré nous!"*

OF THE NINTH PAIR, OR LINGUALIS MEDIUS OR HYPOGLOSSUS.

After passing out from the scull by the anterior condyloid foramen, the ninth nerve adheres to the eighth pair, by cellular filaments and the interchange of nerves. It receives also

* Sabbatier.

branches from the first cervical nerve, or from the branch of union of the first and second cervical nerves. When dissecting in the neck, we find the ninth nerve lying by the side of the internal jugular vein under the styloid muscles, and coming out from under the occipital branch of the internal carotid artery.

The nerve here divides, or it may rather be said to give off that branch which is called the DESCENDENS NONI. The continued trunk of the nerve passes before the external carotid artery, and forwards under the larger branches of veins in a direction tending towards the os hyoides. Here it turns upwards under the stylo-hyoideus and digastricus muscles, and betwixt the stylo-glossus and hyo-glossus. Where the nerve is near the os hyoides, and passing under the stylo-glossus muscle, it sends down a twig which passes to the fore part of the throat, and chiefly to the sterno-hyoideus and thyro-hyoideus.

The continued nerve is distributed to the muscles of the tongue and lower jaw, and glands under the jaw; and it terminates by numerous filaments, which form a net-work amongst the muscles of the tongue; to which is united part of that branch of the fifth pair which goes to the tongue*.

The RAMUS DESCENDENS NONI passes downward, and obliquely over the trunk of the carotid artery, and under the thyroid vein. In the superficial dissection of the muscles of the neck, two slender twigs of nerves will be seen to come from the side of the neck, and crossing the jugular vein, unite to this descending branch. Those twigs come from the second and third cervical nerves†; and a little ganglion or plexus is formed by their union with the descendens noni. From this centre are sent out many delicate and superficial nerves to the omo-hyoideus and sterno-thyroideus muscles.

Thus we find that the ninth nerve has connections with the eighth pair of nerves, with the spinal accessory, the sympathetic, the cervical, and phrenic nerves. When this nerve is injured, the motion of the tongue is lost, but the sense of taste remains unimpaired. On the contrary, when the branch of the fifth nerve going to the tongue is hurt, the sense of taste is lost, while the mobility of the tongue remains‡. Columbus knew a man who had no sense of taste, and who eat indifferently every thing presented to him. When he died, Columbus was curious to know the cause of this, and he found

* This has been called *plexus cerato-basio-stylo-glossus!*

† In some instances those twigs are found to be derived from the first origin of the phrenic nerve.

‡ Soemmerring de Cerebro & Nervis.

that he altogether wanted the gustatory nerve or lingual branch of the inferior maxillary nerve. Cases detailed by Professor Scarpa still further illustrate this fact. A woman, subject to epileptic attacks in an early age, was seized in her pregnancy with an hemiplegia and loss of speech. From this attack, by the use of medicines, she recovered; but in a future labour the disease recurred. Now the cure was less complete; for, though she regained the use of her arms, she never recovered the faculty of speech, or was only capable of articulating with great dissonance the monosyllables, affirming or denying. Upon making her exert herself to speak, they observed no motion in the tongue; and, upon applying the hand under the jaw, they could feel no motion in the muscles of the tongue; yet she relished her food and drink, and had an acute sense of taste, and could swallow easily. He mentions another case, where the patient was attacked with a sense of weight at the root of the tongue, a difficulty of speaking, and copious flow of saliva. In a short time he intirely lost the power of articulating, but retained acutely the sense of taste*.

From the extensive connection of this nerve, particularly with the eighth and sympathetic nerves, we see why tremors of the tongue and aphonia may be occasioned by hysteria, hypochondriasis, colics, or worms in the intestines†.

OF THE CERVICAL NERVES.

First cervical nerve. Tenth pair of the scull. Suboccipital nerve. This is the least of all the nerves of the spine; it arises by two roots from the medulla spinalis. Some difference has been observed in the manner in which those roots collect their filaments; and only the anterior root or fasciculus is described by some authors. The posterior fasciculus is indeed the larger, and comes in a direction different from the general direction of the roots of the other cervical nerves. The roots of the suboccipital nerve are connected with the spinal accessory nerve, but seldom form a ganglion with it; and frequently they form a union with the posterior roots of the second cervical nerve. The fibres of the suboccipital nerve passing transversely and a little obliquely upwards, go out under the vertebral artery, and betwixt it and the first vertebra of the neck. The little trunk of the suboccipital nerve, thus formed, and having escaped from the

* Tabulæ Neurologicæ, Auctore Anton. Scarpa.

† J. F. Will. Bachmer Comment. de 9no pare Nervorum.

spine, rises for a little way upwards, swells into a kind of ganglion, and then divides into two branches.

The anterior of these branches is the smaller. It passes down upon the inside of the vertebral artery; its filaments unite with the hypoglossal nerve, or ninth pair, and with the superior cervical ganglion of the sympathetic and with the first branch of the second cervical nerve*. The larger and posterior branch divides into eight twigs, which are chiefly distributed to the muscles moving the head—to the oblique superior and inferior, the recti postici and laterales, complexus, and splenius. Some of those muscular branches unite with that branch of the second cervical nerve which ascends upon the occiput.

Second cervical nerve. This nerve, arising by a double origin from the spinal marrow, like the other nerves of the spine, passes betwixt the first and second vertebræ. It is larger than the last; and, after forming a little ganglion by the side of the transverse process of the first vertebra, divides into two branches.

The superior branch sends up a considerable division behind the projection of the transverse process of the first vertebra, to unite to the suboccipital or first cervical nerve. Several twigs pass forward to unite with the superior cervical ganglion of the sympathetic nerve, and with some of the more anterior branches of the third cervical nerve, and with the ninth and spinal accessory nerves. Besides these intricate connections, irregular branches of this nerve proceed to the small muscles, moving the head and lying on the fore part of the spine. The *posterior* branch of the second pair of cervical nerves is chiefly a muscular nerve. It rises up by the side of the complexus, gives branches to that muscle and to the splenius, and communicates with the branches of the first cervical. Its branches are also distributed to the upper part of the trapezius muscle, from which they extend along the integuments, covering the occiput even to the summit of the head.

The third cervical nerve, in the first place, communicates with the second and fourth cervical nerves, with the sympathetic and lingual nerves, and sometimes sends down a twig to unite with the origin of the phrenic nerve from the fourth cervical nerve.

From the anterior division of the third cervical nerve, branches pass to the splenius and complexus, and trapezius, and upwards to the ear. We may observe also a cutaneous

* A very small nerve is described by some authors as passing from the anterior division of the nerve, into the canal of the vertebral artery.

nerve which accompanies the external jugular vein, viz. NERVUS SUPERFICIALIS COLLI ; the distribution of which is chiefly to the angle and margin of the lower jaw, while some of its branches enter the parotid gland, and unite with the extremities of the portio dura and other facial nerves.

The SMALL POSTERIOR DIVISION of the nerve passes to the complexus, spinalis cervicis, and multifidus spinæ, while at the same time it unites to the branches of the second cervical nerve.

The FOURTH CERVICAL NERVE, coming out from betwixt the third and fourth cervical vertebræ, divides into its anterior and posterior branches like the other cervical nerves.

The first goes to form, with the third and fifth cervical nerves, the PHRENIC NERVE. It sends also a branch to the sympathetic, to the integuments of the neck and shoulder, and to the supra and infra spinatus muscles. These are called by Soemmerring SUPERCLAVICULARES INTERIORES, MEDII, and POSTERIORES.

The great POSTERIOR DIVISION of the fourth cervical nerve, passes to the muscles of the spine and shoulder, in conjunction with the branches of the third cervical nerve.

FIFTH CERVICAL NERVE.—This nerve comes of course from betwixt the fourth and fifth vertebræ, and from betwixt the scaleni muscles. It divides also into two branches. The SUPERIOR of these passes backwards to the muscles of the back and shoulder, and a branch formed by it; and the sixth passes down under the scapula and serratus major. This superior division of the nerve sends up also two small twigs of communication with the fourth cervical nerve.

The INFERIOR DIVISION of the nerve sends down upon the side of the neck a considerable branch to the formation of the phrenic nerve. It communicates with the root of the sixth nerve, and sends muscular branches backward.

The SIXTH CERVICAL NERVE.—The muscular branches of this nerve are large and extensive in their course. They pass into the levator scapulæ, extend under the trapezius, and unite with the extreme branches of the spinal accessory nerve. They are prolonged to the latissimus dorsi and serratus magnus.—Branches also extend down behind the clavicle, and under the pectoral muscle.

Besides these branches, this nerve communicates with the fifth, and gives out an origin to the phrenic nerve ; and lastly, uniting to the seventh, it passes into the axillary plexus.

The SEVENTH CERVICAL NERVE.—This nerve goes almost entirely to form the axillary plexus. There is a communicating nerve from the last to this, and from that communicating branch

generally there passes off a filament to the phrenic nerve; and from the very root of the nerve there passes off a branch to the lower cervical ganglion of the sympathetic. Irregular twigs also descend from this nerve under the clavicle to the pectoralis minor and major.

The EIGHTH CERVICAL NERVE.—The greater part of this nerve passes to the axillary plexus. It sends small branches to the lower cervical ganglion of the sympathetic, and to the muscles of the breast; which last descend behind the clavicle.

RECAPITULATION OF THE DISTRIBUTION OF THE CERVICAL NERVES.

UPON reviewing the description of these nerves, we find that the general tendency of their branches is backwards over the side of the neck, to the muscles moving the head and shoulders. We find also that they are connected in a very intricate manner with the most important nerves of the cranium. High in the neck and under the jaw, they are connected with the portio dura, with the fifth pair, with the eighth and ninth pairs, and with the sympathetic. Towards the middle of the neck they are still throwing their connecting branches to the descendens noni, and sympathetic, and eighth pair. The lower cervical nerves again are still supporting their connections with the lower ganglion of the sympathetic.

Further, we find the phrenic nerve derived (most frequently) from the third and fourth, and branch of communication betwixt the fourth and fifth. The AXILLARY PLEXUS is formed by the fifth, sixth, seventh, and eighth cervical nerves, and first of the back.

OF THE DORSAL NERVES.

THERE are twelve dorsal nerves. These, as we have described, are formed by two fasciculi of fibres; one from the fore, and the other from the back part of the spinal marrow. These filaments run for some way superficially in the length of the spinal marrow before they pierce the dura mater. They pierce it separately; the posterior branch first forms a ganglion, and then the two fasciculi are united. They are now betwixt the heads of the ribs. We must here recollect, that the trunk of the sympathetic nerve, which passes along the cavity of the thorax, runs down behind the pleura, and passes before the heads of the ribs through all the length of the back. It receives, as it passes the interstices of the several ribs, at each interval, a

communicating nerve from the spinal marrow ; a branch from the intercostal or dorsal nerves.

Those communications are sent in the following manner: the proper dorsal, or intercostal nerve, sends its greater branch forwards betwixt the ribs ; some lesser branches pierce backwards to the muscles of the back : opposite to this there goes out from each nerve the first branch of union with the sympathetic, and this union forms a firm ganglion. Sometimes there run out in this direction two short branches from the spinal nerve, to unite with the ganglion of the sympathetic ; but more commonly there passes in a retrograde direction from the intercostal nerve, where it is about to take its course between the ribs, another branch of communication which joins the sympathetic. Sometimes the dorsal or intercostal nerves send off three communicating branches to the sympathetic.

The intercostal nerves pass on betwixt the ribs, in company with the intercostal arteries, and reach even to the sternum.—In this course they supply the intercostal muscles and triangularis sterni, while they are at the same time sending out branches, which, piercing the intercostal muscles and fascia of the thorax, are distributed to the muscles on the outside of the chest.—Those branches which we mentioned as passing betwixt the heads of the ribs, and which are sent off immediately upon the trunk escaping from the vertebral opening, supply the multifidus spinæ and levatores costarum, and other extensor muscles of the spine. Slips proceeding from the second, third, fourth, and fifth intercostal nerves, send branches to the pectoral muscles, the serratus anticus, and serratus posticus superior, trapezius, and rhomboides. The sixth, and all the lower nerves of the back, send branches from betwixt the ribs to the latissimus dorsi, serratus inferior, and abdominal muscles. The eleventh and twelfth are distributed to the diaphragm, quadratus lumborum, psoas magnus, and iliacus internus.

LUMBAR NERVES.

THE lumbar nerves are five in number. The first comes out under the first lumbar vertebra, and the others in succession. Their trunks are covered by the psoas magnus. They pass very obliquely downward, and the three lowest are of remarkable size.

In the general distribution, we may first remark the posterior branches, which go backwards to the muscles which support and extend the spine. Again, the anterior branches ; which give, 1st, additional branches to the sympathetic nerve

as it passes over the vertebræ of the loins, and by which it is supported and reinforced till it terminates in the pelvis ; 2dly, they have frequent connection with each other, and with the last nerve of the back, and first of the sacrum ; 3dly, they send out branches, delicate but of great extent, to the muscles of the loins and back, and to the abdominal muscles and integuments of the groin and scrotum ; 4thly, the principal anterior branches of the lumbar nerves pass down to form (along with the great nerves of the sacrum) the anterior crural nerve, the obturator, and the great ischiatic nerve.

SACRAL NERVES.

The nerves which come out from the extremity of the medulla spinalis, or cauda equina, through the sacrum, are in general five in number. Sometimes there is one more or less. The first division of each sacral nerve is into those branches which pass out by the posterior foramina of the sacrum, and those which, by the anterior foramina, come into the pelvis.—The posterior branches are very small, and pass to the muscles supporting the spine ; while the anterior ones are particularly large, especially the first and second, which, with the lowest of the loins, go to form the largest nerve of the body, the ischiatic nerve.

It is difficult to recollect the distribution of the several branches of the lumbar and sacral nerves, when taken thus together ; but when we deliver the description of the nerves of the thigh and leg, we count them, and hold them in remembrance with comparative ease. At present we are best prepared to follow the sympathetic nerve in its course.

OF THE GREAT SYMPATHETIC NERVE, OR INTERCOSTAL NERVE.

Notwithstanding the idea of this nerve which I have endeavoured to convey, I conceive that we must still continue to speak of the origins of this nerve in the usual way, for the sake of simplicity and arrangement.

The sympathetic nerve is in general considered as originally derived from the sixth pair ; or, we may say, it takes its origin from the sixth, where it passes by the side of the carotid artery, and from the vidian branch of the fifth pair. It appears without the scull, sometimes behind and sometimes before the carotid artery, and sometimes it is double in its exit from the base of the scull. Almost immediately after it has escaped from the scull, it forms its first ganglion ; which is ve-

ry large and remarkable, and has the name of the SUPERIOR CERVICAL GANGLION of the sympathetic nerve. It is of a soft consistence and reddish colour, and it extends from the scull to the transverse process of the third vertebra. It gradually tapers downwards until it terminates in the slender nerve, which in the neck is extremely small. This ganglion has much variety of shape in different subjects, and may be said in general to receive twigs of nerves upon the back part; it gives them out upon the fore part.

The superior cervical ganglion of the sympathetic nerve receives nerves from the second, third, and fourth cervical nerves, and even sometimes from the root of the phrenic nerve. It has also connections with the hypo-glossal, par vagum, and glosso-pharyngeal nerves. It sends out branches to unite with the glosso-pharyngeal, and which follow that nerve in its distribution to the tongue and pharynx. Many of its branches surrounding the carotid artery form connections with the internal and external laryngeal nerves, and proceed in meshes, or form plexus along with the branches of the artery. These may be followed to great minuteness.

To be more particular in the description of these anterior branches of the sympathetic nerve, they are called the NERVI MOLLES, or NERVI VASORUM. They are nerves peculiarly soft, with a greater proportion of cellular membrane; they spread in net-works along the arteries, and form frequent connections by little knots like small ganglions. Classed with these nervi vasorum, are branches which pass forward from the upper ganglion of the sympathetic, to unite with filaments from the internal laryngeal nerve of the par vagum, and which form the external laryngeal nerve. It is remarked, that none of these branches of the sympathetic nerve are distributed to the larynx and pharynx without being mingled and associated with the glosso-pharyngeal nerve, or with the pharyngeal branch of the par vagum.* Of the nervi molles, some form a plexus upon the internal carotid artery. These are extremely soft and pulpy, and are united with branches which descend from the glosso-pharyngeal nerve. A net-work is also formed, which covers the beginning of the external carotid artery.— From this, as from a centre, branches are sent out with the arteries to the neck, and face, and glands under the jaw; and these last, with a mesh which passes up upon the temporal artery, unite with the portio dura of the seventh pair.

It has been often observed, that the branches of the carotid artery have a peculiar provision of nerves, and that these nerves

* Scarpa.

are more numerous and minutely distributed than in any other part of the body. There are indeed no nerves in any part of the body which have so extensive and intricate connections with important nerves as the cutaneous nerves of the face and neck. This distribution of the nerves is, I conceive, a provision for that power possessed by the imagination, or rather that uncontroulable connection which exists betwixt the feelings and the action of the vessels in blushing.

The lowest of the nervi vasorum or molles, sent off from the superior ganglion of the sympathetic nerve, descends in the course of the trunk of the nerve, and forms, with other branches, the superior cardiac.

This nerve, generally called NERVUS CORDIS SUPERFICIALIS, passing down in the direction of the trunk of the sympathetic nerve, and near the longus colli muscle, is for some length a very slender branch; but in its course it receives two, three, or four additional twigs from the sympathetic, and branches which come under the carotid artery from the pharyngeal nerves, or nervi molles. When this superior cardiac nerve is within an inch or two of the subclavian artery, branches of union pass betwixt it and the recurrent nerve of the par vagum; and branches of the nerves passing to the heart from the lower cervical ganglion, also join it. It then, attaching itself to the investing membranes and sheaths of the carotid and subclavian arteries, forms with others a plexus of nerves, which run along the great vessels to the heart.

The continued trunk of the sympathetic, where it emerges from the superior cervical ganglion, is extremely small. It descends behind the carotid artery, and lies near to the spine. When opposite to the fifth and sixth cervical vertebræ, the inferior cervical ganglion of the sympathetic is formed.— In this course, twigs of communication pass betwixt it and the cervical nerves, or join it with the beginning of the phrenic nerve.

But not unfrequently there are three cervical ganglions formed by the sympathetic nerve; the superior, middle, and inferior ganglions: or it happens that we find the sympathetic nerve split into two branches in the neck; one of which forms the middle, and the other the lower ganglion.

There are received by the MIDDLE CERVICAL GANGLION, or, THYROID GANGLION, branches of nerves from the third, fourth, fifth, and sixth cervical nerves, and also sometimes from the phrenic nerve. The ganglion is by no means constantly found, and it is irregular in its size and shape. When large, and in what may be considered as its more perfect state, it gives off some considerable branches. Of these, part unite with the su-

perior cardiac nerve already mentioned; others form the great or deep cardiac nerve, while lesser ones play round the subclavian artery, and unite with the lower cervical ganglion, or the upper thoracic ganglion.

The deeper cardiac branch of the sympathetic, splitting and again uniting so as to form rings, runs outwards, attached to the arteria innominata and arch of the aorta, to the heart. In this course, while it passes before the trachea, it forms connections with the recurrent branch and trunk of the par vagum. Under the arch of the aorta, we find this branch concentrated to form the GANGLION CARDIACUM of Wrisberg, or GANGLION MOLLE and PELLUCIDUM of Scarpa. This ganglion is like a mere enlargement or swelling of the nerve. From this, four or five branches may be enumerated; 1st, a branch passing behind the pulmonary artery to the back of the heart, and following the left coronary artery; 2dly, a small division to the anterior pulmonary plexus of the par vagum; 3dly, a pretty considerable branch which, passing behind the aorta, and betwixt it and the pulmonary artery, is distributed with the right coronary artery to the anterior part of the heart. On the left side of the neck, the sympathetic, receiving on the one side branches from the cervical nerves, and on the other giving off branches, which descend behind the carotid artery to the heart, (viz. the superior cardiac) often splits before it forms the middle or thyroid ganglion, and sometimes throws its branches over the thyroid artery, and the ganglion lies upon that artery. Again, from the ganglion there descend two series of numerous lesser filaments, which form meshes upon the thyroid and subclavian arteries to the heart. Others proceed downward behind the arteries to the lower cervical ganglion. Those branches which descend upon the arteries, intangle the roots of the thyroid, transversalis cervicis, and internal mammary arteries, in their plexus; these uniting, follow the subclavian artery, and form again a plexus upon the arch of the aorta. This is joined by branches from the par vagum and recurrent. The principal branches of this plexus terminate in the cardiac ganglion under the arch of the aorta*.

The LOWER CERVICAL GANGLION† of the sympathetic nerve is placed upon the limits betwixt the neck and thorax upon the head of the first rib, and by the side of the musculus longus colli; and it is in part covered by the root of the vertebral artery. The ganglion is of an irregular cushion-like shape. It

* This defcription of the fympathetic nerve on the left fide follows the more ufual diftribution, but is not peculiar to the left fide

† The lower cervical, or, *cardiac* ganglion of the fympathetic nerve.

lies close to the cervical nerves which go to the brachial plexus, and it receives branches from them*. Branches also pass from this ganglion to the par vagum and recurrent, and also pass on to the cardiac and pulmonic plexus. That nerve, which must be considered as the continued sympathetic, throws a ring round the root of the vertebral artery, and sending out branches upon the subclavian, terminates in the first dorsal or thoracic ganglion.

THE SUPERIOR THORACIC GANGLION.

THIS ganglion surpasses the other thoracic ganglions in size. It is, indeed, frequently composed of many branches of the nerve in the neck, coming both before and behind the subclavian artery. It receives also nerves from the three or four lowest cervical nerves, and first dorsal nerve. It is of a very irregular figure, or rather it varies exceedingly in its shape; so that by various anatomists it is described as round, oval, triangular, quadrangular, cylindrical!—Filaments proceed from this ganglion into the canal of the vertebral artery, and to the cellular coat of the subclavian artery, and to the cardiac plexus, and also to the pulmonic plexus; or to supply the posterior surface of the lungs.

SYMPATHETIC NERVE IN THE THORAX.

THE sympathetic nerve, (as we have explained in describing the dorsal nerves,) through all its course in the thorax, has additional branches from the dorsal or intercostal nerves. It forms also, while it is lying on the side of the vertebræ, a division in the thorax, which it will be important to recollect. This nerve is sent more forwards upon the body of the vertebræ, and passes into the abdomen betwixt the crura of the diaphragm; while the trunk of the sympathetic continues its course by the heads of the ribs, passes under the ligamentum arcuatum, and downwards upon the lumbar vertebræ.

The SPLANCHNIC NERVE, then, is this anterior branch of the sympathetic in the thorax. It is the great nerve of the viscera of the abdomen. It generally has two or four roots from the trunk of the sympathetic nerve, where it is opposite to the sixth, seventh, and eighth intercostal nerves. It is seen lying under the pleura, and passing obliquely over the bodies of the

* And even it receives ſometimes from the fifth and ſixth, more rarely the ſeventh and eighth, from the firſt and ſecond of the back; and laſtly, from the phrenic nerve.—Sometimes theſe connections are wanting.

lumbar vertebræ, from the seventh to the tenth. It then passes betwixt the crura of the diaphragm, enters the abdomen, and forms the great semilunar ganglion.

One or more branches are sent forward from the sympathetic, commonly from the ganglions, opposite to the interstice betwixt the ninth and tenth, or tenth and eleventh ribs.—These also pass the diaphragm, and unite with the semilunar ganglion. There is, however, a considerable variety to be observed both in the origins of the splanchnic nerve, and in the number of these subsidiary branches. A larger branch, going off betwixt the tenth and eleventh ribs, is so common, that it has the name of SPLANCHNICUS MINOR, or, ACCESSORIUS. This nerve as frequently terminates in the renal plexus, as in the semilunar ganglion; or sometimes it sends branches to both.

CÆLIAC GANGLION AND PLEXUS.

THE ganglion which is called the semilunar ganglion, has no regular shape—and least of all when it is fully dissected. It is formed by the splanchnic nerve, and by branches which come from the lumbar nerves. It lies by the side of the cæliac artery, and consists of many lesser ganglions, (sometimes to the number of eleven or twelve,) matted together into a glandular-like shape.

The semilunar ganglions of the splanchnic nerves lying on each side of the root of the cæliac artery, their connection with each other is frequent and intricate; so that they throw a mesh of nerves round the root and branches of this artery, which is the great source of vessels to the stomach, liver, and spleen.—This plexus, formed by the semilunar ganglions round the cæliac artery, is the solar or cæliac plexus.

CÆLIAC PLEXUS.

THE cæliac plexus is the great source of nerves to the higher viscera of the abdomen. The splanchnic nerves are the great, but not the only nerves which form this plexus. The par vagum sends branches down from the stomach which join it; and even the phrenic nerve, which is the nerve of the diaphragm, sends down twigs to unite to the branches of the splanchnic and par vagum. We shall find also small nerves which come from the seat of the kidney, and which are derived from the superior lumbar nerves. These pass across the crura of the diaphragm, and enter into the cæliac plexus. In pursuing the nerves of the viscera further, we have it no

longer in our power to follow individual branches, but have rather to mark the course, and enumerate the various sources of the plexus, and net-work of nerves which follow the great vessels.

From the cæliac plexus, there pass out, 1. Nerves which accompany the phrenic arteries upon the lower surface of the diaphragm. 2. Nerves to the liver :—and of these there are two plexus, the right and left hepatic plexus ; one passes along the vena portæ, biliary ducts, and right hepatic artery, to the right side of the liver, the gall-bladder and ducts ; this of course is the RIGHT HEPATIC PLEXUS : the LEFT HEPATIC PLEXUS passes along the left hepatic artery ; and this has connection with the cardiac nerves, branches of the par vagum. 3. That plexus, which runs upon the lesser curve of the stomach, while it is formed in a great measure by the par vagum, has also connection with the solar or cæliac plexus. 4. The plexus of nerves which pass to the lower orifice of the stomach and duodenum is chiefly a division of the right hepatic plexus. These nerves, to the liver, stomach, and duodenum, are attached to the branches of the cæliac artery. Along the great splenic artery, which is also derived from the cæliac artery, there passes out a plexus of nerves to the spleen. From this splenic plexus there pass nerves to the great omentum ; and they even unite with those passing out upon the duodenum, and which attach themselves to the right epyploic artery, and take a course upon the great curvature of the stomach.

Thus the solar or cæliac plexus is a great central net-work of nerves, which pass out in divisions to the liver, spleen, pancreas, stomach, duodenum, and omentum.

SUPERIOR MESENTERIC PLEXUS.

THE place and connections of the superior mesenteric plexus is at once known, when it is considered that it is formed upon the root of the superior mesenteric artery.—It is formed by the cæliac plexus being continued down upon the aorta so as to involve the root of the mesenteric artery, and by nerves coming over the side of the vertebræ of the loins from the lumbar nerves. This plexus spreads betwixt the lamina of the mesentery, and extends upon the branches of the artery, and of course is distributed to the small intestines and part of the colon. It consequently supplies the mesenteric glands, and sends nerves also to the pancreas, that join those which it receives from the splenic plexus.

INFERIOR MESENTERIC PLEXUS.

The same mesh of nerves, being continued down upon the face of the aorta, surround the lower mesenteric artery, and follow its branches. This is the lower mesenteric plexus, or mesocolic plexus ; and it is formed in a great measure from the branches of the continued trunk of the sympathetic nerve. As this plexus spreads upon the branches of the lower mesenteric artery, it passes to the left side of the intestinum colon and rectum—while the lower mesenteric plexus is continued from the upper one. On the side of the lumbar vertebræ it is continuous with the renal and spermatic plexus ; and towards the pelvis, with the hypogastric plexus.

Before considering the other lesser plexus of nerves in the abdomen, it is necessary to follow the continued trunk of the sympathetic nerve which we had described as following closely the lateral part of the dorsal and lumbar vertebræ, whilst the splanchnic nerves pass obliquely over them to the viscera of the upper part of the belly.

The CONTINUED TRUNK of the SYMPATHETIC NERVE, after it has given off the splanchnic nerve in the thorax, sends several small nerves forward over the vertebræ to the mediastinum and sheath of the aorta. It then passes the diaphragm, keeping close to the transverse process of the vertebræ. When, however, it comes lower upon the lumbar vertebræ, it lies more upon the side of their bodies, and the connections with the lumbar nerves are by small and numerous twigs which stretch over the side of the vertebræ. In this course, it is giving off upon the fore part numerous irregular twigs to the several plexus. Where it lies under the vessels which pass to the kidney, it sends up some branches to the renal plexus.

The renal plexus, however, is not entirely formed of these branches of the continued sympathetic, but is rather a continuation from the cœliac and superior mesenteric plexus ; while the lesser splanchnic nerve, which was sent off in the thorax, also terminates in it. This plexus is thrown over the vessels of the kidney, and forms several little ganglions.

From the renal plexus descends the SPERMATIC PLEXUS.—This plexus of nerves in woman follows the spermatic artery in its distribution to the ovaria and uterus.

In passing down upon the loins, the sympathetic nerve forms five or six ganglions with the branches from the lumbar nerves. These are oblong, angular, stellated—irregular in their form, as in their number, situation, size, or the twigs which, in their union with the sympathetic, form them. Betwixt these gan-

glions or connections with the lumbar nerves, the sympathetic is not always one nerve, but is sometimes split into several smaller nerves, which unite again. From the sympathetic nerves of either side we have to observe frequent interchange of branches, which sometimes attach themselves to the lumbar nerves, sometimes creep under the aorta, or unite to the plexus covering the face of the aorta.—There are several little ganglions formed by these nerves upon the face of the lumbar vertebræ: they have the name of ganglia accessoria.

Before the sympathetic nerve descends into the pelvis, it has become extremely delicate. In many subjects it seems to terminate in the last lumbar, or first sacral nerve; but, upon more minute dissection, lesser branches will be found to descend amongst the loose cellular substance of the pelvis.—When regular, or perhaps we may say with truth when regularly and fully dissected, the sympathetic nerves of each side are seen to descend upon the fore part of the sacrum, and form connections with the sacral nerves similar to those with the dorsal nerves.—As they descend, they of course approach, and finally unite in an acute point on the os coxigis.—At the points of union of these extreme branches of the sympathetic nerves with the branches of the sacral nerves, small ganglions are formed; and there pass out branches from them, which cover the intermediate surface of the sacrum with an extensive plexus. The ultimate ganglion, formed by the union of the two sympathetic nerves, is the *coxygeal ganglion*, and from it there pass three or four nerves to the extremity of the rectum.

HYPOGASTRIC PLEXUS.

This is a plexus which lies on the side of the pelvis, and involves the hypogastric artery. It consists of the nerves passing to the parts contained in the pelvis; which do not, however, pass in distinct branches, but, like those of the abdomen, are formed into minute interwoven net-work. The hypogastric plexus takes no determinate origin, but is continuous with, or formed by, the extreme branches of the sympathetic nerves, the extremity of the spermatic plexus, the sacral nerves, (and particularly the third sacral nerve,) and by the branches of the accessory ganglions on the sacrum.

OF THE PHRENIC NERVE.

The phrenic or diaphragmatic nerve arises from the cervical nerves, passes obliquely down the neck, enters the thorax, and is distributed to the diaphragm.—This nerve has much va-

riety in its derivation. It comes chiefly from the third cervical nerve, deriving also some twigs from the fourth and second. But sometimes it takes an origin very high in the neck, from the par vagum or ninth nerve; and even the superior cervical ganglion of the sympathetic is described by some as furnishing a root.—Lower in the neck it will be found in some subjects to derive very small additional twigs from the fifth or sixth cervical nerves, or lower ganglion of the sympathetic.

The phrenic nerve, thus formed, descends into the thorax betwixt the subclavian artery and vein. In the chest it proceeds downward and forward, attached to the mediastinum, and before the root of the lungs.* It takes its course upon the outside of the pericardium, and from the pericardium slips off to the surface of the diaphragm. From the position of the heart, the left phrenic nerve differs a little in its course from the right; and it passes over the pericardium, covering the apex of the heart. The phrenic nerve of the right side, besides supplying the diaphragm, sends down through the diaphragm (to the right side of the vena cava) the ramus anastamoticus.—This communicates with the semilunar ganglion of the sympathetic, or with the division of the solar or cæliac plexus which passes along the phrenic arteries. From the phrenic artery of the left side, there pass down with the œsophagus small nerves which, appearing in the abdomen, unite with the cæliac ganglion, or some of its divisions; and both phrenic nerves will be found by some minute branches to unite to the par vagum.

These, however, are but minute branches. The great destination of the phrenic nerve is to the diaphragm. The branches strike out from the diaphragm like roots from a centre; they pass some way only covered by the pleura, and then pierce into the substance of the muscle. There are innumerable experiments upon living animals, which shew the connection of this nerve with the action of the diaphragm. When the nerve is stimulated, the diaphragm is excited to contraction; when cut, pressed, or tied, it becomes relaxed and inactive, and there is difficulty of respiration; when the spinal marrow is injured

* Ludwig. Martin, in the Edinburgh Eſſays, and others, explain the action of the diaphragm upon the ſuppoſition of the mechanical preſſure of the lungs upon the phrenic nerve. It is a piece of doctrine inconſiſtent with knowledge of the general laws of the œconomy. It is repugnant to comparative anatomy, and it is evident that the ſoft and elaſtic diſtention of the lungs could not compreſs the firm nerve. Moreover, the lungs when diſtended do not preſs upon the mediaſtinum, for it is the dilation of the thorax which cauſes the lungs to inhale the atmoſpheric air. See *Wriſberg de Nervo Phrenico.* Sandiſt. Theſ. vol. ii. p. 260. It is betwixt the heart and muſcles of reſpiration that the ſtrict relation and ſympathy exiſt.—When in turning the child in utero, and when the cord has been preſſed, I have felt the ſtrong convulſive *fetches* of the muſcles of reſpiration endeavouring, by the play of the lungs, to compenſate for the loſs of the placenta.

low in the vertebræ of the neck, or in the vertebræ of the back, the external muscles of respiration cease to act, but the diaphragm still continues its function ; and in this case, as observed by Mr. Hunter, the patient lives for some days, breathing by the diaphragm. If the phrenic nerves be divided in a living animal, the diaphragm ceases to act, and the abdominal muscles lose their opponent muscles, and remain as in expiration ; but still the respiration is continued by the motion of the ribs. If after this the spine be divided, the motion of the lungs ceases entirely, and the animal dies suddenly.—The injury of the spinal marrow above the origin of the phrenic nerves, is of course suddenly fatal, because it destroys at once the function of the diaphragm, and muscles moving the chest. From the connection of the phrenic nerve with the par vagum, we may explain the sympathy betwixt the trachea and the diaphragm, how the irritation of the trachea occasions coughing and the convulsive action of the diaphragm ; in the same manner in the affection of the stomach, singultus, from the sudden action of the diaphragm and abdominal muscles, (which usually alternate in their action,) may be explained. Again, a connection of nerves might be followed from the origins of the phrenic to the sympathetic nerve, and branches of the fifth pair to the nose : which accounts for that sympathy of action which occasions sneezing from irritation of the membrane of the nose.

NERVES OF THE ARM ; AXILLARY, OR BRACHIAL PLEXUS.

The nerves which proceed from the spine, and go to supply the arm, are formed into an intricate plexus before they divide into the several nerves of the arm.

This brachial, or axillary plexus, is formed of five of the spinal nerves ; viz. the fifth, sixth, seventh, and eighth cervical nerves,* and the first dorsal nerve. The highest of these nerves proceed from betwixt the fourth and fifth cervical vertebræ ; the last from betwixt the first and second dorsal vertebræ. They pass out betwixt the middle and anterior division of the scaleni ; and even while covered by these muscles, and before they have proceeded far from their foramina, the last nerve of the neck and first of the back unite.†—The plexus is continued from above the clavicle to the edge of the tendon of the latissimus dorsi. It allows of no natural division. The

* This is of courſe counting the ſuboccipital as the firſt cervical nerve.

† Before the nerves which form the plexus intermix their filaments, or are connected together, they ſend off ſmall branches to the ſcalenic muſcles, to the muſcles of the ſpine, and to the levator ſcapulæ. The branches which they give to the ſympathetic nerve, we have already noticed.

axillary nerve passes for some way close under it, and then perforates betwixt the divisions which form the radial nerve.

From the axillary plexus proceed these nerves:

1. The thoracic nerves.
2. The supra and infra scapular nerves.
3. The circumflex, or articular nerve.
4. The perforans casserii, or external cutaneous nerve.
5. The radial nerve.
6. The ulnar nerve.
7. The muscular spiral nerve.
8. The internal cutaneous nerves.

1. The THORACIC NERVES. Although the nerves which supply the muscles of the chest are derived from the intercostal nerves, as we have seen, yet there also pass off branches from the axillary plexus to the great and little pectoral muscles, to the latissimus dorsi, to the skin and mamma. These thoracic branches proceed from the upper division of the plexus, or that which gives out the external cutaneous, and one of the roots of the radial nerve.

2. The SUPRASCAPULAR NERVE comes off from the upper edge of the plexus, and is the highest of the branches. It runs towards the root of the coracoid process, it passes through the notch of the scapula, and goes to supply the supra and infra spinatus muscles, the teres minor, and the subscapularis.

The SUBSCAPULAR NERVES come out from the posterior part of the plexus along with the articular nerve. They are attached to the subscapular muscle, they turn round the fleshy edge of the muscle, and insinuate their branches betwixt the tendon of the latissimus dorsi and the teres major.

3. The CIRCUMFLEX, or ARTICULAR NERVE, or AXILLARIS, lies very deep. It comes from the back part of the plexus, passes behind the neck of the humerus, and above the tendon of the latissimus dorsi, and teres major. One of its branches we trace into the teres major, while another passes round the bone, and is distributed to the under surface of the deltoid muscle, the joint, and the cellular membrane.

4. PERFORANS CASSERII, or the EXTERNAL CUTANEOUS NERVE. This nerve passes through the coraco-brachialis muscle before the os humeri, to gain the outside of the arm. From its perforating this muscle, and being described by Casserius, it is called the nervus perforans Casserii. Before passing through the coraco-brachialis muscle, it sends down a

branch of communication with the radial nerve; and in many subjects it will be found to be like a branch from one of the origins of the radial nerve. Where the nervus perforans lies betwixt the brachieus internus muscle and biceps, (and, of course, after it has perforated the coraco-brachialis muscle), a branch or two are sent up to the heads of the biceps muscle; another branch turns inward to the belly of that muscle; and, finally, twigs pass inward to the cellular membrane, which involves the brachial artery.

The continued nerve passes obliquely across the arm, and under the biceps. When approaching the outside of the arm, it divides into three small branches; one to the integuments which are upon the supinator longus, another to the integuments on the inside of the fore-arm, and a third, which continues its course along the edge of the supinator longus to the wrist. Of this prolonged branch of the perforans Casserii, a minute twig is lost on the ligament of the wrist, another passes to the ball of the thumb, and a third goes round to the integuments of the back of the thumb.

5. The RADIAL NERVE. This nerve is formed by those divisions of the plexus which surround the brachial artery, and sometimes by a division of the perforans Casserii. It takes its course by the side of the brachial artery, and gives off no branches until it has sunk under the aponeurotic expansion of the biceps muscle.

When the radial nerve has come to the bend of the arm, it gives off three branches. The first belongs to the pronator teres, flexor radialis, and palmaris longus, and flexor digitorum; a second passes to the pronator teres; and a third to the deep muscles of the fore-arm, and to the flexors of the thumb particularly, and also to the pronator quadratus muscle. The radial nerve, continuing its course down the fore-arm betwixt the flexor sublimis and profundus digitorum, sends off other branches to those muscles. Before passing under the ligament of the wrist, it gives out a branch which emerges from the tendons, and passes to the integuments, short flexor, and abductor muscles of the thumb.

The trunk of the radial nerve passes with the tendons of the flexor muscles of the fingers under the ligament of the wrist. In the palm of the hand it divides into five branches; the first passes to the abductor and flexor pollicis brevis; a second goes to the adductor pollicis, and side of the thumb next the fore-finger; the third passes to the fore-finger, and to the lumbricalis muscle; the fourth to the side of the fore and middle fingers; and the fifth to the sides of the middle and

little finger. All these nerves, while in the palm of the hand, send off branches to the lumbricales muscles.

6. The ULNAR NERVE comes off from the lower part of the plexus in union with the internal cutaneous nerve. It descends upon the inside of the arm, and is tied down by the fascia, and then passes behind the internal condyle of the humerus.—While above the bend of the arm, it gives off a superficial branch to the integuments on the inside of the arm, and the ulnar side of the fore-arm; at the same time it sends a muscular branch through the triceps muscle, along with the arteria profunda inferior. Immediately above the elbow joint, twigs are sent off, some of which accompany the ramus anastamoticus major of the brachial artery. After passing the condyle of the humerus, it sends a branch to the flexor carpi ulnaris, and to the head of the flexor digitorum profundus. It then sinks deeper betwixt the flexor ulnaris and flexor digitorum sublimis; it is here connected with the ulnar artery, and descends along with it to the wrist. In this course, along the fore-arm, the ulnar nerve gives branches to the flexor digitorum sublimis. Often it sends a branch of communication to the radial nerve, while some few lesser muscular nerves are sent off, and accompany the branches of the ulnar artery.

When arrived near the wrist, the ulnar nerve divides into two branches. The continued trunk passes on under the protection of the tendon of the flexor ulnaris, and then under the arcular ligament into the palm of the hand; while the branch takes a turn under the flexor ulnaris, and over the edge of the flexor digitorum profundus. It passes then over the lower end of the ulna to the back of the hand. On the back of the hand it is found branching over the expanded tendons and under the veins, and is finally distributed to the back of the little and ring fingers. This is the *ramus posticus*.

The continued ulnar nerve passes under the palmaris brevis muscle and palmar aponeurosis, and above the flexor brevis and adductor minimi digiti. Here it divides into two, (the sublimis and profundus of Camper,) and these again into four principal branches—to the integuments on the ulnar edge of the hand, and adductor minimi digiti—to the outer edge of the little finger,—to the side of the little and ring fingers, and a branch which communicates with the radial nerve.

Albinus, Monro and Camper differ in regard to the distribution of nerves to the lumbricales muscles, which only proves that the twigs passing to those little muscles are irregular.—They come chiefly from the deep branch of the ulnar nerve, whilst others are from the radial nerve.

7. The MUSCULAR SPIRAL NERVE. We find the external

cutaneous nerve, or perforans casserii, passing before the arm-bone. The muscular spiral nerve passes behind the bone, and takes a spiral turn under it to get to the outside of the arm. It perforates the flesh of the arm betwixt the middle and the short head of the triceps muscle. Before it perforates the triceps muscles, the muscular spiral sends off branches which pass over the tendon of the latissimus dorsi; and before it enters the triceps muscle, it may be observed to divide into several branches. Three of these may be mentioned: a branch to the middle head, and one to the short head of the triceps muscle, and a third and larger nerve which pierces betwixt the muscles, along with the trunk of the nerve.

This last nerve does not follow the trunk of the nerve in its course, but perforating the triceps more directly across, it comes out behind the supinator longus, where it takes its origin from the os humeri. This is a cutaneous branch, and might be considered as the external cutaneous nerve with as much propriety as the perforans casserii. Often we shall find some lesser branches of the muscular spiral nerve piercing the fibres of the triceps muscle, and terminating in the skin.

The great cutaneous division of the nerve, after piercing the triceps muscle, takes its course along the integuments covering the supinator longus muscle; and here it sends a branch in upon the bend of the arm, and on the edge of the triceps muscle. It then descends upon the outside of the fore-arm, and divides into three principal branches, and then again into innumerable cutaneous twigs, and is continued down over the back of the thumb and hand.

But the great division of the muscular spiral nerve comes out betwixt the head of the supinator longus muscle and the bone, and is deep seated. This branch then lies betwixt the supinator longus, and brachieus internus; and here it gives off several small twigs to the muscles. Continuing its course by the side of the supinator longus and flexor radialis, it divides into a deep and superficial branch. The superficial branch passes down on the side of the tendon of the supinator longus, and near the wrist it becomes quite superficial, and is distributed to the integuments of the back of the hand.

8. The INTERNAL CUTANEOUS NERVES. Of those we may describe three:—

1. The *great internal cutaneous nerve*. This nerve is derived from the ulnaris at its root, or comes off from the plexus along with it, passes down the arm, giving off no considerable branches, accompanies the basilic vein and twists its branches over it, divides into four branches upon the fascia of the fore-arm, and running betwixt the fascia and veins of the

fore-arm, it is finally distributed to the cellular membrane and integuments, while one of its branches reaches to the ligaments of the wrist.

2. The *cutaneous nerve of Wrisberg* comes sometimes from the axillary plexus, as a distinct nerve; sometimes it is a branch of the great internal cutaneous nerve; sometimes it is derived, or a nerve which takes its place is derived from the intercostal nerves. This nerve of Wrisberg is distributed to the integuments of the arm, and terminates near the internal condyle.

3. The *upper and internal cutaneous nerve* comes from the first intercostal nerve, or from the second, and passes out betwixt the first and second ribs. It supplies the integuments of the arm, and the glands and fat of the axilla.*

There are besides several nerves derived from the intercostal nerves, which cross the axilla, and supply the arm-pit and side.

NERVES OF THE THIGH, LEG, AND FOOT.

In tracing the nerves of the lower extremity, we find no difficulty in the arrangement at least, for they fall into a very simple and natural order. They are all derived from the lumbar and sacral nerves. The great nerves are three in number. One passes out under Poupart's ligament to the extensor muscles of the leg, *viz.* those which lie on the fore part of the thigh. This of course is called the anterior crural nerve. The second nerve is the obturator nerve, so called because it passes out from the pelvis by the thyroid hole. This nerve lies amongst the deep muscles of the thigh, and distributes its branches chiefly to the adductor muscles. The third nerve is the greatest nerve of the body, *viz.* the ischiatic nerve. It passes out from the back part of the pelvis, through the sacro-sciatic notch, and takes its course down the back of the thigh into the ham. In this course it supplies the muscles lying on the back of the thigh, but its chief destination is to the leg and foot.

OF THE CUTANEOUS NERVES OF THE THIGH.

It will be found considerably to take from the intricacy of the minute anatomy of the nerves of the lower extremity, to dispose first of these nerves which lie under the integuments of the thigh.

* See Syſtem of Diſſections, vol. ii. plate 1. g.

These cutaneous nerves of the thigh come from the lumbar nerves, or more immediately from the anterior crural nerve.—They pierce the tendon of the oblique muscle of the abdomen, or pass under Poupart's ligament, and are distributed to the groin, scrotum, and betwixt the fascia and integuments of the fore part of the thigh. There may be described five cutaneous nerves on the fore part of the thigh, *viz.* the *external cutaneous*, the *middle cutaneous*, the *anterior cutaneous*, the *internal cutaneous*, and those of the groin and scrotum.

The EXTERNAL CUTANEOUS NERVE is that which comes out from the belly near the superior spinous process of the ilium. It divides almost immediately into two great branches, and in the front view of the thigh the anterior branch alone is to be seen. It takes a course above the fascia in the direction of the line which divides the vastus externus from the rectus femoris, and terminates near the knee, while the posterior branch passes over the tensor vaginæ femoris, and down upon the outside and back of the thigh. It is derived from the third lumbar nerve.

The MIDDLE CUTANEOUS NERVE rises from amongst the integuments of the groin, and emerges from under the fascia near the upper edge of the sartorius muscle. It passes down upon the rectus muscle, and is distributed to the integuments in three or four divisions.

The ANTERIOR CUTANEOUS NERVE comes out to the integuments very high up, and in the middle of the groin betwixt the pubes and tuberosity of the os ilii. It passes down the thigh along the surfaces of the sartorius and vastus internus muscles. This, like all the other cutaneous nerves, runs along above the fascia, and on the lower surface of the skin.

The INTERNAL CUTANEOUS NERVE is the least regular. It does not pierce the fascia in one trunk, but sends three, four, or five branches through the fascia, which are distributed to the integuments on the inside of the thigh. Some of these, after running a considerable way under the fascia, emerge and encircle the inside of the knee.

Besides these more remarkable cutaneous nerves, there come down small nerves to the groin and scrotum. The first lumbar nerve sends down the external spermatic nerve. This joining the spermatic plexus, helps to supply the cord and testicle; and in women the same nerve goes to the womb within the pelvis, and following the round ligament, terminates on the fat of the pubes and groin. A branch from the second lumbar nerve passes also to the glands and fat of the groin, the pubes, and cremaster muscle. This branch is remarkable for

the circuitous course it takes round the ilium and inside of the ligament of the thigh.

ANTERIOR CRURAL NERVE.*

THIS nerve arises from the union of the second, third, and fourth of the lumbar nerves, or the second and third lumbar nerves uniting into one trunk, are afterwards joined by a division of the fourth,† or the anterior crural, is formed by the anterior branch of the third and the first branch of the second lumbar nerve,‡ or by the four first lumbar nerves; and the anterior crural nerve, at its origin, lies under the psoas magnus, and, as it descends, it holds its course between the psoas magnus and iliacus internus. It then descends towards the thigh, and passes out under Poupart's ligament; and in its course along the brim of the pelvis, it is for some way covered by the external iliac artery. Here, while within the pelvis, it gives off several small nerves, which pass into the iliacus internus, and under the psoas magnus muscles. These form a kind of small plexus.

As the anterior crural nerve passes under Poupart's ligament, it splits into its numerous branches which supply the muscles and integuments on the fore part of the thigh. From the fore part of the nerve there is sent out a musculo-cutaneous branch, which, while it descends and supplies several of the muscles of the thigh, gives out the middle cutaneous nerve. The anterior cutaneous nerve is sent off lower down, but almost immediately after it has passed under Poupart's ligament. The internal cutaneous nerve is sent off from some of those branches which run under the internal articular artery.

The last of the cutaneous branches of the anterior crural nerve, and the most important, is the NERVUS SAPHENUS, or CUTANEUS LONGUS. This is the chief cutaneous nerve of the leg; but it is to be distinguished as a particular nerve, so high as under the external articular or circumflex artery, being a division of what is called the NERVUS LONGUS. This nerve is sometimes joined by a branch of the obturator nerve; and the muscular branches which it gives off, pass into the vastus internus.

When we are dissecting in the course of the femoral artery, we have to observe two nerves running parallel to, and connected with the sheath of the artery. That which is on the inside is the largest, the course of which we shall prosecute. It

* *Crural nerve, truncus lumborum, femoralis magnus.*
† Fischer—Walter.
‡ Sabbatier and Haller.

follows the artery through the tendon of the triceps muscle, but it does not descend into the ham with the popliteal artery. It comes out again through the tendon with the perforating branches of the popliteal artery, or with the upper and internal articular artery. It then becomes a superficial nerve, and descends upon the inside of the leg with the saphena vein, to the inner ancle and foot.

Those two nerves, which are so closely connected with the femoral artery in the middle of the thigh, are very often taken up with the extremity of the artery in amputation. This occasions twitching in the stump and a fetid discharge.

Where the continued nerve descends upon the inside of the leg, it sends out many twigs to the integuments, and is entangled with the saphena vein. Here it has been pricked in bleeding in the ancle.—Sabbatier gives us an instance of this. The patient had been previously subject to nervous affections. She left in the instant of the operation an acute pain, which was succeeded by convulsive motions, first of the limb and then of the whole body. These attacks returned from time to time, she lost her health, and for many years was still in suffering almost continual.—He relates to us another instance of the injury of this nerve accompanying the saphena vein, in the case of a young man who received a wound with the small sword in the inside of the knee. There came on much fever and swelling of the part, with great pain of the limb. This subsiding, there followed slight trembling of the limb, which gradually increased to an extreme degree. The caustic was proposed, but the patient had not resolution to let it be applied. After long suffering with exhausted strength, he was at last relieved by nature, and his health gradually returned.

These branches we have mentioned are only the cutaneous or superficial branches of the anterior crural. The larger and more numerous set of branches are those to the muscles lying on the fore part of the thigh. These diverge suddenly into innumerable twigs, and are entangled with the branches of the arteries, and follow them in their distribution. There can be no excuse for bestowing particular names on these branches; to say that one is the branch to the pectinalis, another the branch to the sartorius, another to the rectus, &c. is sufficient.

OBTURATOR NERVE.

This nerve arises by fasciculi from the second and third lumbar nerves, and sometimes by a small twig from the fourth. It is formed, however, chiefly by the third lumbar nerve. It then lies under the internal border of the psoas magnus. It

descends into the pelvis, and goes obliquely downwards to pass through the ligamentous membrane which fills up the thyroid hole. The obturator nerve, before it escapes from the pelvis, sends off a branch which, accompanying the parent nerve, is given to the external obturator muscle. When it has escaped from the pelvis, this nerve lies before the heads of the triceps, and behind the pectinalis muscle; and it here divides into two branches in the very middle and internal flesh of the thigh. The anterior of these branches passes down betwixt the adductor muscles, or heads of the triceps, supplies those muscles and the gracilis, and sends a branch of communication with the saphenus nerve. The posterior division goes down betwixt the adductor magnus and brevis, sends branches to the obturator externus and adductor brevis, and continues its course downwards before the great fleshy partition of the adductor muscles, and parallel with the crural vessels, to the fat above the inner condyle of the femur.

THE ORIGIN OF THE ISCHIATIC NERVE.

THE ischiatic nerve is formed by the two last nerves of the loins, and the three first of the sacrum: or we may describe its origin more particularly thus; the anterior branch of the fourth lumbar nerve and the trunk of the fifth uniting, form a strong cord of about two inches in length; this root is joined to another nearly as large, formed by the first and second sacral nerves; and again, a third division joins it from the inferior branch of the second sacral nerve and from the third*. The ischiatic nerve is thus formed of three great roots matted together into a kind of plexus, and then passes betwixt the pyriformis muscle and the gemini, and thus escapes from the back part of the pelvis by the great ischiatic notch.

But before following this great nerve into the thigh, we must take notice of many lesser nerves sent out from the sacral nerves, and from the trunk of the ischiatic nerve. These nerves pass to the muscles and integuments of the nates and back of the thigh to the perineum and private parts.

OF THE LESSER NERVES WHICH GO OUT FROM THE BACK PART OF THE PELVIS.

1st. THERE pass off branches from the second and third lumbar nerves, which form a muscular nerve of considerable

* This third and loweſt origin, before uniting with the others to form the iſchiatic nerve, gives out many ſmall branches to the hypogaſtric plexus and viſcera of the pelvis, to the perineum and private parts.

size. This muscular nerve passes down upon the inside of the pelvis, escapes from the back part of the pelvis, and is distributed to the gluteus medius, the gluteus minimus, and the tensor vaginæ femoris.

2d. There pass off one or two very small nerves from the body of the ischiatic nerve, while yet within the pelvis, or from the middle divisions of its origins, which go to the pyriformis and gluteus medius muscles.

3d. Just where the great nerve passes over the posterior ligaments of the pelvis, there goes off a twig to the obturator externus gemini and quadratus femoris. While these nerves are sent off upon the anterior face of the nerve, there goes backward a large fasciculus of nerves to the glutei muscles, and to the integuments of the nates*.

There proceeds a nerve somewhat more important than these from the third sacral nerve, *viz.* the NERVUS PUDENDUS. This nerve passes out above the short sacro-ischiatic ligament, and re-enters under the long sacro-ischiatic ligament. It then runs by the side of the ramus ischii, and ascends in the perinæum and branches to the erector penis, accelerator urinæ, and transversalis perinei, and passes on to the integuments and external parts of generation.

OF THE CUTANEOUS NERVES OF THE BACK OT THE THIGH.

WHEN the integuments are dissected off from the nates and back of the thigh, we see two sources of the cutaneous nerves; first from the lumbar nerves, which give out many small nerves which pass over the spine of the os ilii, and the branches of the anterior and outer cutaneous nerve; and secondly, from under the lower margin of the great gluteus muscle, there come many extensive cutaneous nerves. These are derived from the nervus cutaneus posterior et superior, and branches of the ischiatic nerve, in this manner;

Just as the great ischiatic nerve has escaped from the pelvis, it is joined by the SUPERIOR and POSTERIOR CUTANEOUS NERVE; or, rather, a small twig is sent off from the great nerve to join this cutaneous nerve† on its emerging from the pelvis. It divides into several branches, and it is one of these

* Branches of that root of the ischiatic nerve which is derived from the third sacral nerve, go also out to the buttock; and some describe a superior, middle, and inferior cutaneous nerve of the nates.

† The posterior cutaneous nerve rises in general from the trunk of the ischiatic nerve, within the pelvis, and is joined by a branch from the third sacral nerve.—Loerd. Haase.

which may be seen superficial and above the delicate fascia, running down upon the outer hamstring muscles, to the back of the knee-joint. Another branch piercing the fascia separately, comes down upon the integuments covering the outer and back part of the thigh, and terminates on the outside of the knee. A little further down, the ischiatic nerve gives off small nerves to the muscles surrounding the hip-joint; and, whilst the sciatic nerve is passing over the quadratus femoris, the INFERIOR and INTERNAL CUTANEOUS NERVE is given off. This nerve runs down even to the inside of the calf of the leg. The EXTERNAL and POSTERIOR CUTANEOUS NERVE is a branch sent off from the ischiatic nerve, after it has descended from under the gluteus maximus, and just before its division into two fasciculi, *viz.* the tibial and peroneal nerves. This external and posterior cutaneous nerve passes down upon the integuments of the back part and outside of the leg.

OF THE TRUNK OF THE ISCHIATIC NERVE IN THE THIGH.

BUT we must not allow these lesser branches to distract our attention from the general course of the great nerve, which passes over the gemini muscles, betwixt the tuberosity of the ischium and the trochanter major, then runs deep under the bellies of the hamstring muscles, and is lodged immediately in the great cavity behind the knee-joint, in company with the popliteal artery and vein. In this course the sacro-sciatic gives off branches to the quadratus femoris, the biceps cruris, semitendinosus, and semimembranosus and triceps.

A little below the middle of the thigh, the great ischiatic nerve divides into the internal and greater, and the lesser and external popliteal nerves. But as this is really the division into the two great nerves of the leg, we take the more determinate names of tibial and fibular nerves.

TIBIAL NERVE.

THE greater and more internal of these divisions of the popliteal nerve, is the tibial nerve. Whilst it is yet in the hollow behind the joint formed by the hamstring tendons, it gives off a nerve which comes out from the ham, and descends superficially on the back of the leg. This has been called RAMUS COMMUNICANS TIBIEI. When this nerve has arrived opposite to the beginning of the tendon achillis, it turns a little to the outer side, passing upon the outer margin of the achilles tendon, over the outer side of the heel-bone, and is finally distri-

buted on the outside and fore-part of the foot. Upon the back of the leg, this nerve unites with a branch descending from the fibular nerve, nearly in the same course, and with the same destination.

After giving off this superficial branch, the tibial nerve sends branches to the back of the knee-joint and popliteus muscle, to the plantaris muscle, and to both heads of the gastrocnemius. It then descends behind the articulation, and behind the head of the tibia. It then passes under the origins of the soleus, and betwixt the soleus and flexor longus digitorum pedis, and tibialis posticus, and descends to the inner ancle. In this course it furnishes many branches to the lower part of the popliteal muscle, to the tibialis posticus, to the flexor communis digitorum, and to the flexor pollicis longus, and many of these branches, and in cutaneous twigs. We have also to observe a particular branch which the tibial nerve detaches, which passes betwixt the heads of the tibia and fibula, and goes to supply the muscles arising from the fore part of the interosseous ligament. Further down, two or more small branches of the nerve also perforate the interosseous ligament, to supply the muscles lying on the outside of the tibia. The tibial nerve, in its course amongst those posterior muscles, accompanies the posterior tibial artery. When it has arrived behind the inner ankle, it sends off a branch to the integuments of the inside of the foot, and to the abductor muscle of the great toe. Continuing its course by the side of the heel-bone and under the ligament, it begins to split into those branches which are naturally called the plantar nerves, because of their lying in the sole of the foot.

THE PLANTAR NERVES.

The internal plantar nerve passes over the abductor muscle of the great toe, and by the inside of the short flexor to the first metacarpal bone; and in this course it gives out several twigs to the muscles of the sole of the foot. It now divides into three branches. These are distributed to the great toe, to the second, the third, and one side of the fourth toes; and these nerves in their course give branches to the lumbricales and interossei muscles.

The external plantar nerve is the lesser of the two. It gives branches to the short flexor and adductor of the little toe, and to the massa carnea Jacobi Silvii. It gives also a deep branch to the third and fourth interosseous muscle and adductor muscle of the great toe. Another of its branches makes the arch with the internal plantar nerve, while its extreme distribution is to the little toe, and to one side of the fourth toe. These

nerves of the sole of the foot are connected with the internal and external plantar arteries, and are protected like them by the plantar aponeurosis.

THE FIBULAR NERVE.

THE fibular nerve is the more external division of the popliteal nerve. It separates from the tibial branch about four inches above the knee-joint ; it does not pass down under the gastrocnemius, like the tibial nerve, but turns towards the outside of the joint, and passes round the head of the fibula, and under the origin of the peroneus longus.—Before the fibular nerve passes from behind the joint, it gives off several branches. There are sent down two branches to the integuments. One of these branches unites with the communicans tibiei, and descends with it to the outer ankle. Sometimes this anastamosis is formed high in the leg upon the heads of the gastrocnemius. More generally there is a double communication formed by these nerves about the termination of the belly of the gastrocnemius muscle in the achilles tendon. This prolonged branch of the fibular nerve terminates upon the side and upper part of the foot, and upon the little toe. There are also some nerves sent off from the fibular, which are distributed about the back and sides of the knee-joint.

When the fibular nerve has turned over the head of the fibula, it divides into two great branches. The DEEPER SEATED of THESE BRANCHES, though it is not the largest of them, may be considered as the continued trunk. It passes deep amongst the muscles, lying betwixt the tibia and fibula, and supplies the tibialis anticus, the extensor communis digitorum, extensor longus pollicis, and the peroneus brevis. Thus the deeper division of the fibular nerve, taking its course between the tibialis anticus, and the peroneus longus muscles, and lower down betwixt the tibia and extensor pollicis longus, continues giving off branches in rapid succession, and when it arrives at the annular ligament, it is much diminished. Here it divides into the *ramus dorsalis*, *pedis profundus* and *superficialis*.—This division is made after the nerve has crossed under the tendon of the tibialis anticus muscle, and, while it lies betwixt the lower heads of the tibia and fibula.—Although they are distinguished by the name of deep and superficial branches, they are both deep compared with the extremities of the great and outer division of the peroneal nerve. The branch which lies most towards the outside of the foot, passes under the extensor digitorum brevis muscle, and on the outside of the tarsus. It distributes its branches to the extensor digitorum brevis, and

interossei muscles. That branch which is more towards the inside of the foot, although distinguished by the term superficialis, goes forward not only under the fascia which covers the foot, but also under the tendons ; and after dividing and again uniting, and after sending off some small branches, it comes out betwixt the great toe and the second toe, and sends numerous branches to their contiguous surfaces.

The GREAT SUPERFICIAL DIVISION of the FIBULAR NERVE is sometimes double, or immediately splits into two. Its first branches are to the peroneus tertius, extensor longus digitorum, and to the peroneus brevis and secundus. The trunk or principal division runs down under the head of the peroneus longus, and then coming out from under it, continues its course beneath the strong aponeurosis, which covers the muscles on the fore part of the leg. It then pierces the aponeurosis and becomes cutaneous, and runs obliquely down to the convexity of the foot, giving off in its course a nerve which passes over the outer ancle.

THE METATARSAL NERVES.

WHEN the superficial branch of the peroneal nerve descends before the ankle-joint, it divides into the metatarsal nerves, or the rami dorsales pedis. The EXTERNAL of those branches passes above the tendons, and above the tendinous expansion on the dorsum pedis ; is united to the extreme branches of the ramus communicans tibiei, and is finally distributed to the outside of the third toe, to the fourth, and to the inside of the little toe.—The INTERNAL branch is again subdivided ; one branch extends over the middle of the foot to the second and third toes, while the other passes straight along the metatarsal bone of the great toe (above the tendons ;) sends many branches over the inside of the foot, and terminates on the inside and dorsum of the great toe.

END OF THE FIRST PART.

INTRODUCTION.

OF THE SENSES.

THE Senses are those faculties by which the active principle within us has communication with the material objects by which we are surrounded. Through them, we receive those simple sensations which are the first elements of our thoughts, and the means of developing all the powers of the understanding. The exercise of our senses, however, is familiar to us from so early a period, that we never think of attending to their first simple intimations: before we are capable of reflecting on the nature of the perceptions which the several senses convey, they are so complicated and distorted by habits, association, and abstraction, that observation comes too late for us to ascertain the simple progress of nature. Philosophy may indeed revive the natural feelings of wonder at the spectacle of the universe; but often, instead of humble and cautious investigation, we follow the dictates of a creative imagination, and run into error and delusion in studying the operations of nature.

To the man, however, who looks upon nature with the calm and chastened delight which is the character of true philosophy, there is a conviction, that such researches may be carried too far. Wherever he directs his attention, whether to the structure of the human body, the physiology of vegetables, or the phænomena of chemical science; whether he endeavours to comprehend the system of the universe, or pores over the minutiæ of natural history, he finds every where a limit placed to his enquiries; a line which no industry or ingenuity can enable him to pass. We may please ourselves with conjecture beyond this limit, but we find that all our opinions on these subjects are merely a dream of something allied to the impressions of our gross senses. The agency of

the senses, the intercourse betwixt mind and matter, and the influence of the will over the body, are mysterious, and, probably, inexplicable phenomena ; yet we scruple not to explain them precisely and mechanically ; we reduce them to the level of our own capacity in the same manner as we fabricate to ourselves the idea of a Deity by the combination of all human perfections. When we imagine that we have discovered the secret of these mysteries, it is mortifying to find ourselves without any sign or language by which to communicate those great truths to the companions of our studies : we struggle for expression ; and, as all our ideas upon such abstract subjects are derived from analogy, we express our opinions respecting the powers of the mind, or the manner in which we perceive the objects of the senses, in the same language, and by reference to the same notions, which belong to the sensations themselves. From this scantiness and inaccuracy of language, it unavoidably happens, that very different ideas of the operation of the senses are expressed by several men in the same terms ; and in attempting to convey our ideas in language more precise and definite, we are insensibly led to materialize the faculties of the mind, and to make the operations of the senses merely mechanical. What other explanation can we give of theories, which suppose the nerves to be tubes carrying animal spirits, or containing an elastic ether ; or which represent them as vibrating cords, and reduce all the variety of sensation to the difference of tension and tone ? These are, indeed, what Dr. Reid calls them, " unhandy engines for carrying images."

Nothing has been undertaken in philosophy but entire systems, fathoming at once the greatest depths of nature. The custom has been to frame hardy conjectures ; and if upon comparing them with things there appeared some agreement, however remote, to hold that as fully sufficient. What chimeras and monstrous opinions this method of philosophising has brought forth, it would be more invidious than difficult to specify.

Bacon and Newton laid down the principles of philosophising on this basis, that on no account are conjectures to be indulged concerning the powers and laws of nature, but we are to make it our endeavour, with all diligence, to search out by experiment the real and true laws by which the constitution of things is regulated. In the subject now before us, we have a very remarkable proof of the superiority of investigation by experiment over the lazy indulgence of conjecture ; and I hope the whole tenor of the following account of the senses will strengthen the conviction of the student, that it is only by assiduous study, and patient observation of nature, that he is

to look for the attainment of knowledge in the medical profession.

The office of the brain and nerves is to receive the impressions of external bodies, by which corresponding changes and representations are made in the mind. We know nothing further than that, by the operation of the senses, new thoughts are excited in the mind. Betwixt the sensation excited in the organ of the external sense, and the idea excited in the brain, there is an indissoluble, though inexplicable, connection; the brain is not sensible, nor does the eye perceive, but both together give us the knowledge of outward things. But when the sensation is once received and communicated to the brain, it is treasured there, and may afterwards be excited independent of the external organ: hence comes the term internal senses.

INTERNAL SENSES.

Though I treat professedly of the external organs of the senses only, it may be necessary here, to say a few words on the internal senses. It appears that all sensations originate in the external senses or organs receiving the impressions of outward bodies: imagination is the power of combining these sensations, and memory the power of recalling them. These are powers of the mind, which, by the constitution of our nature, are gradually acquired, and increased by exercise. In infancy, the perceptions are simple and transitory; the memory is perfected by degrees, and with the store of ideas the imagination is invigorated.

It is in the combination and reciprocal effects of the mental powers and of the impression on the external senses, that we are to find an explanation of the operation of attention and its history. When the mental powers are led to the contemplation of an idea which assimilates easily with the sensation about to be presented by the external organ, the perception is quick, and the idea vivid; but when the mind is strongly impressed and occupied with the contemplation of past ideas, the present operation of the sense is neglected and overlooked. Thus, the vividness of the perception or idea, is always proportionate to the degree of undistracted attention which the mind is able to bestow on the object of sensation or of memory. In solitude and darkness, the strength of the memory in the contemplation of past events is increased, because there is no intrusion of the objects of the outward senses; and the deaf or blind receive some compensation for their loss in the increased powers which are acquired by a more frequent and undistur-

bed use of the senses which remain, and a keener attention to the sensations which they present. On the other hand, when we are under the enchantments of a waking dream or revery, our attention is wholly detached from the present objects of the senses ; and in this state we may even continue to read without understanding. This absence, in a certain degree, is common, natural, and by no means unpleasant : it is the exertion of the faculty of the mind. But it may become disease ; for health consists in the due correspondence betwixt the excitement and the vigorous action of the body, and the operation of the mind when roused by the external senses.

The mind (united to the body) suffers in the diseases of the body. In the debility of the body, in fever, in spasms, and pain, the faculties of the mind languish, or are roused to unequal strength or morbid acuteness. Sometimes the phantasms and internal sensations of things once received by the outward senses, become so strong in the mind, as to be mistaken for objects actually present. Such phrenzy or delirium arises from a disordered and acutely sensible state of the internal senses.— These impressions being great in degree, hurry and bustle are in the countenance of the patient, and uncommon strength and violence in his actions ; as passion gives uncommon excitement to one in health, with a disregard or forgetfulness of all other things. In health, however vigorous the force of imagination may be, there is still a conviction that the ideas which it presents are not realities, and the operation of the external senses preponderates in recalling the attention to what exists around us. But when the internal perceptions become so strong as to be mistaken for realities, the effect is falsely attributed to the organs. It indeed sometimes happens, that this false perception is really owing to disease in the organ ; while it also occurs, that a too vivid perception of things absent proceeds from an affection of the brain, and not of the outward senses.

There is still another degree or class of diseased sensation consisting in the modification of objects which are actually present to the senses. But this modification of things present (as when bodies actually at rest appear to be in motion) is not always occasioned by optical deception. Objects seem to turn round, and this we shall afterwards find to proceed from the insensible motion of the eyes ; but this motion of the eyes is occasioned by the disordered state of the internal sensation and the same feeling will be experienced if the eyes are shut.— For example, when we turn quickly round on our heel until we become giddy, it would appear that there is a disturbance of the usual order of sensation, and that the course of our in

pressions is reversed; for while our sensations were formerly directed entirely by the impression made on the outward senses, the sensorial impressions now draw after them a sympathetic motion of the external organs.

This inverted communication betwixt the mind and organs is better exemplified in the organ of speech. Thoughts excited in the mind are represented by the signs of these ideas i[illegible] speech. There occurs, however, not unfrequently, a diseas[illegible] state of these operations of the internal senses, in which [illegible] ideas excited in the mind cannot be associated with th[illegible] propriate expressions; and although the patient has a[illegible] idea of what he means to express, he cannot recollect [illegible] which belong to it; so that, when he asks for o[illegible] names another which has no connection with it. [illegible] perfectly sensible, and yet he cannot correct hir[illegible]

There are more frequent instances of di[illegible] sensation in hypochondriacs. In them, th[illegible] and unusual feelings are falsely attribute[illegible] there is really no affection: for these feel[illegible] [illegible]a-rent cause; they proceed from a disor[illegible] [illegible]tion in which the usual course of the impr[illegible] [illegible] as to occasion the patient falsely to attrib[illegible] [illegible] sound and healthy parts. Thus, indiges[illegible] [illegible] the bile, flatulency, colic, &c. often do n[illegible] [illegible]npressions, but the pains are attributed to [illegible] That there is sometimes an actual connec[illegible] [illegible]xt the external parts, to which these feelin[illegible] [illegible] the internal organs, is evident from the f[illegible] [illegible]n the outward and sound parts has occasion[illegible] [illegible]ternal organs. To such d[illegible]dered trans[illegible] [illegible]tation of the internal parts [illegible] attr[illegible] [illegible]ant and ludicrous ideas whic[illegible] [illegible]ondr[illegible] [illegible] these people, there are dis[illegible] [illegible]rts [illegible] which, during their healthy st[illegible] ha[illegible] [illegible]ed in the short introductory [illegible] ne[illegible] [illegible]have no feeling nor consciousness o[illegible] [illegible]has no power. But although in [illegible]h[illegible] [illegible]my there is no immediate route by [illegible] a[illegible] these organs can be transmitted to [illegible], it may happen, that, in their dis[illegible] [illegible]ions do arise which forcibly attract the [illegible]ntio[illegible] be an obscurity in the feelings produced by their de[illegible]nt, insomuch, that the mind may be deceived in regard to the direction of the sensation conveyed from them.

During health, there are vicissitudes of consciousness, sense, and voluntary motion, and of rest from voluntary exertion, in-

sensibility, and oblivion of the past. This is true, however, only comparatively, and by a gross reference to degree; for even during natural sleep there is not a total oblivion of past perceptions, nor is there always a total unconsciousness of the present, as the senses are in part awake; some one train of ideas is present to the mind; and the lapse of time is observed. Even these perceptions are sometimes so strong as to be followed by voluntary exertion, and yet the patient remains asleep. Whatever conduces to take the excitement from the mind, or lessens the vivacity of its impressions, conduces to sleep.— Thus, rest, stillness, and darkness, by excluding the most lively impressions conveyed by the senses; and hæmorrhagy and evacuations, by lessening the velocity of the circulation; induce sleep. Again, compression of the returning blood from the head, by giving it a slow languid motion, and by depriving the vessels of their freedom of action, also conduces to sleep; because, as formerly remarked, the powers and faculties of the brain must be renovated through the means of the circulation.

By long watching and fatigue, the body is brought nearly to a feverish lowness. By sleep, rest is given to the voluntary muscles, and an abatement of the vital motions ensues; the quiescent state of the muscles brings back the blood to the heart, with a slow, regular, and calm progression; the heart is restored to its slow and equable pulsation; the breathing becomes slower; and the wasted strength of the system is recruited.

We may define sleep to be a state in which the sensations are dull, the voluntary muscles inert, and the vital motions calm and regular. In dreaming, the sensations are dull and obscure, but the imagination more alive and active; unnatural sleep, or soporific diseases, may be characterized by the disordered imagination, and disturbed vital and voluntary motions. The vital actions, which are calm, slow, and equable, during natural sleep, become oppressed; the sensibility, which is gradually diminished upon the approach of sleep, but always capable of being roused by the senses, becomes quite oppressed; the voluntary muscles continue relaxed, as in sleep, or convulsed by irregular motions. In apoplectic diseases, the functions of the viscera proceed, and are but partially impeded; but when the circulation of the blood and play of the lungs are obstructed, the operations of the mind are not equally unconcerned in the paroxysm; for in syncope, the sudden depletion of the blood-vessels of the brain causes instant loss of sense and of voluntary motion.

If natural sleep is not profound, the imagination is awake;

but there may be false perceptions, false judgment and associations, and disproportionate emotions; and if sensations are perceived, they do not produce the ordinary associations.—If such a state of the intellectual functions occurs during the waking state, it becomes delirium. That this delirium is analogous to the perturbed state of the imagination during sleep, appears from the delirium in fevers uniformly showing its approach in the patient's slumbers only. It is a disposition to form false images and associations, which, in the beginning, the excitement of the outward senses has power to counteract, insomuch that a patient can be roused from delirium as he can be roused from sleep: but, bye and bye, the external senses lose their superiority, and their excitement is attended with unusual associations; they no longer convey impressions to the intellect, but become subservient to and modified by it, and the judgment, which depends on the due balance of memory and imagination, is lost. In fever, the delirium is transitory; in low fevers, it is combined with a comatose state. In melancholy, the delirium runs upon one object chiefly, or trains of ideas, which refer to the patient's health and corporeal feelings. In madness, the variety is infinite; but chiefly consisting in a vitiated imagination and perverted judgment, with fierceness and increased power of corporeal exertion.

There are five organs peculiarly adapted to convey sensations to the mind; and they may be considered as forming a medium of communication betwixt the external creation and the sentient principle within us; they are at the same time the bond of union betwixt sentient beings. These organs are called the EXTERNAL SENSES; viz. the sense of seeing, the sense of hearing, the sense of smelling, the sense of tasting, and the sense of touch. Individually, these organs convey little information to the mind; but by comparison and combination, the simple and original affection or feelings of the mind are associated and combined to infinity, and administer to the memory and imagination, to taste, reasoning, and moral perception, the passions and affections, and every active power of the soul.

BOOK I.

OF THE EYE.

CHAP. I.

INTRODUCTORY VIEW OF THE PRINCIPLES OF OPTICS.

LIGHT is a matter thrown out from ignited, or reflected from shining, surfaces; and which enters the eye and impresses that organ with the sensation of sight. The minuteness and inconceiveable velocity of light, the facility with which it penetrates bodies of the greatest density and closest texture, without a change of its original properties, makes it the source of the most wonderful and astonishing phænomena in the physical world.

The smallest stream of light which propagates itself through a minute hole, is called a ray; and, as rays of light pass through a uniform medium in a straight course, they are represented by mathematical lines. The sun is the greatest source of light, and perhaps the original and only source. But light is not uniform in respect of colour: every part of a ray is not capable of exciting the idea of whiteness which the whole raises. White light is composed of different kinds of rays, which individually give the sensation: one of red, another of orange, a third of yellow, a fourth of green, a fifth of light blue, a sixth of indigo, and a seventh of a violet or purple.* These are named the prismatic colours; because, in the spectrum produced by making a ray of light to pass through a prism, these several colours are seen in the succession in which they are

* There is a fact not a little extraordinary regarding the emanation of rays from the sun, and which has been discovered in the present day, viz. that there are invisible rays, giving heat but no light, which are less refractable than the coloured rays; and that all rays, in proportion to their refrangibility, have less power of producing heat. See Herschel on the invisible rays of light. Phys. Trans. 1800, part ii. p. 284.

above enumerated. Each of these rays individually impresses the eye with its own colour; but when they all impress the eye at once, the sensation upon the organ of sight is a compound effect: no individual colour is presented, but that mixed light which is called whiteness, and which may be divided into its individual colours by passing it through a prism.

It is the nature of most bodies to absorb some of these rays of light and to reflect others from their surface; consequently, the colours of bodies depend upon the particular rays which are reflected from them, or upon the combination of such rays as are reflected from them; and a body appears of that colour of which the light coming from it is chiefly composed.

When a ray of light passes from a rarer to a denser medium, or from a denser into a rarer, it alters its course, if there be any obliquity in the original direction; but if it strikes from one medium into another perpendicularly to the surfaces, its original direction is not changed. If the ray passing from the air enters obliquely into glass or water, or any denser medium, it turns more towards the perpendicular; but if it passes through the glass and emerges again into the air, it resumes its original direction, diverging from the perpendicular. This effect of different mediums upon the ray of light, is called refraction: when a ray of light impinging upon a surface does not enter, it rises again to the angle of its incidence; and this is reflection.

The prism is a piece of glass of a triangular form; the inclined surfaces of which, when placed in the course of the ray of light, refract, and separate the several parts of the heterogeneous ray, and show its compound nature. If the sun be permitted to shine into a dark room through a small hole in the window-shutter, and the beam of light be made to fall upon a glass prism, it is, in passing through the glass, separated into its constituent parts; because the several coloured rays have different degrees of refrangibility, in the order in which I have already enumerated them. If the rays, after passing through the prism, be made to pass also through a convex glass, they are brought again to a point in the focus of that glass; and the effect of the whole colours thus re-united, is perfect whiteness. We might suspect that the beam of light were homogeneous, and that the degree of refraction gave different colours to the rays, were it not proved, that how much soever any of the coloured rays is further refracted, it does not change its nature: nor will rays suffer any change by reflection from bodies of different colours, for minium will appear yellow, green.

blue, &c. according to the colour of the ray of the light directed upon it.*

As the impression of light remains some time upon the nerve of the eye, it gave Sir Isaac Newton the opportunity of examining, whether each coloured ray makes a distinct impression upon the eye, or whether they so affect each other as to impress the sense of whiteness on the eye. When a burning coal is whirled in a circle, the eye perceives an entire circle of fire, because the impression made by the coal in any point of the circle remains until the coal returns again to the same place, and renews the sensation. When all the varieties of colours are painted in a circle, and turned in the same way with the burning coal, they must each make their separate impression upon the optic nerve ; but the general sensation is whiteness ; or when the teeth of a comb are drawn across the stream of light issuing from a prism, the different colours are intercepted in such quick succession, that a perfect whiteness is the result of the mixture of impressions. There are many experiments which show, that the inequalities of the refraction of light are not casual ; that they do not depend upon any irregularity of the glass : on the contrary, it is proved, that every ray of the sun has its own peculiar degree of refractability, according to which, it is more or less refracted in passing through pellucid substances, and always in the same manner : and, lastly, that the rays are not split and multiplied by the prism.

When a ray of light falls upon the surface of glass obliquely, it inclines to a line drawn (through the point of incidence) perpendicular to the surface.

Fig. 1.

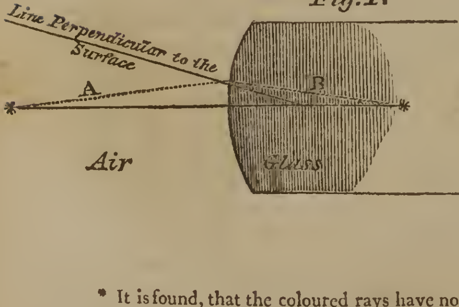
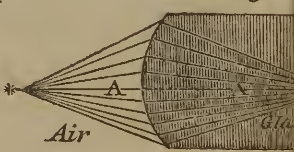


Fig. 2



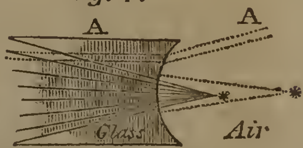
* It is found, that the coloured rays have not all the same power of illuminatin objects ; the orange ray possesses this property more than the red ; the yello more than the orange, &c. ; and the maximum of illumination lies in the brighest yellow or palest green ; nor do the several rays equally affect the thermomete See Herschel's Exp. Trans. 1800, p. 2. p. 255.

Thus the ray A. fig. 1, proceeding from the object *, is refracted upon entering the mass of glass in the direction B, having a tendency towards the perpendicular line. By this means, if a number of rays proceeding from any one point, as in fig. 2., fall on a convex or spherical surface of glass, they will be inflected so as to gather about the perpendicular line A A in the centre of the glass: which perpendicular line is the axis of the glass. If the rays of light proceeding from an object be made to strike into a mass of glass with a concave surface, the obliquity with which they impinge upon the surface, being the reverse of the convex surface, they are not made to converge upon the central line, but diverge from it.

Farther, the rays of the sun when passing from a medium of glass into the air, are turned, by refraction, farther off from the central line to which they were drawn in entering the convex surface of glass. But if the rays, in passing through the glass, were in a direction converging to the perpendicular line, they will be made to converge still farther, as is seen here in fig. 3.

Fig. 3.

Fig. 4.



If, however, the rays be made to pass from glass into the air, and the surface of the glass be concave as in fig. 4., the rays will be made to have a less degree of convergence, so as to remove the image * farther from the surface of the glass. But if the rays passing through the medium of glass have no convergence, but pass in parallel lines, they will diverge as the lines A A, fig. 4. do, when they emerge from the concave surface of the glass.

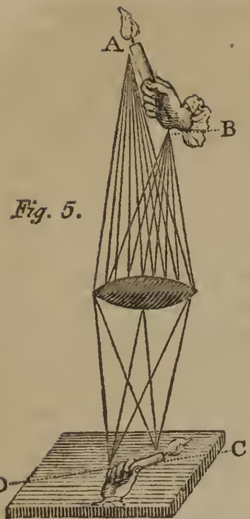


Fig. 5.

We see, then, the operation of a double convex glass, in forming the image of a luminous body upon a surface. If, for example, such a glass be held between a candle and a piece of white paper, (the distances being properly adjusted), the image of the candle will appear very distinctly upon the opposed surface, but inverted; because the rays coming from the point A fig. 5., converge at C, and those from the point B at D.

Before proceeding farther in this short exposition of the principles of optics, it will be necessary to take a very slight view of the structure of the eye.

SIMPLE IDEA OF THE STRUCTURE OF THE EYE.

THE eye being that organ by which we are sensible to the rays of light, may be considered as consisting of two parts; that which receives the impression, viz. the retina or expanded nerve, and which is indeed the organ of the sense; and the tunics and humours, the apparatus by which the rays of light are made capable of forming an impression on the retina, or proper organ of the sense.

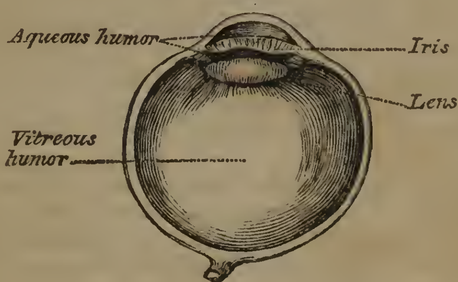
In an anatomical enquiry, it is chiefly the latter division of the subject which must occupy our attention; for, although we are necessarily led to consider the nature of the substance of the retina, the manner in which it is expanded, and supported by adhesion, and nourished by vessels, we must not venture far in the attempt to investigate the manner of its receiving or conveying the image of objects to the sensorium. We must turn to investigate the more useful subject of the structure, use, and diseases* of the humours and coats of the eye.

It is the first principle of the constitution of the eye, that the rays of light must be so concentrated as to impinge strongly on the expanded nerve or retina in the bottom of the eye. Now, as we have seen, that a lens (which is a double convex

* Of the diseases only as they relate to the explanation of the structure and œconomy of the eye.

glass) is necessary, so to concentrate the rays of light proceeding from an object, as to form a small and lively image of it, (as in marginal plate, fig. 5.), so, in the same manner, an essential part of the eye is the lens, which brings the rays of light to a focus; and that the lens may make the rays proceeding from an object converge into an accurate focus, so as to form a distinct image on the eye, the vitreous humour is interposed betwixt the lens and the surface of the retina: again, it is necessary to the constitution of the eye, that, in order to increase the sphere of vision, the anterior part of it shall project and form a large segment of a small circle, so as to take a greater circumference into the sphere of vision than could have been done, had the larger sphere of the eye-ball been continued on the fore part. Another necessary part of the apparatus of the eye is the iris, which is a curtain in the anterior chamber of the eye, perforated with a hole, which is capable of being enlarged or diminished so as to admit a larger or smaller stream of light as may be necessary to perfect vision. In this provision, we see the necessity of the anterior humour of the eye being different from the others; being merely an aqueous secretion, while the others possess a degree of firmness, viz. that the iris, or curtain of the eye, may move with perfect freedom in it.

Fig. 6.



The three humours of the eye are thus situated, and have this general character:

1. The AQUEOUS HUMOUR is the anterior humour of the eye. It distends the anterior and pellucid part of the eye, so as to increase the sphere of vision. It is perfectly fluid, and of a watery consistence, that it may allow free motion to the iris.

2. The LENS OF CRYSTALLINE HUMOUR is placed immediately behind the perforation in the iris; which perforation is called

the pupil. The lens collects the rays of light like a double convex glass, so as to concentrate them, and make a more forcible image on the bottom of the eye.

3. THE VITREOUS HUMOUR is behind the lens. It distends the general ball of the eye into a regular sphere, that it may move easily in the orbit; and its diameter in the axis of the eye is so proportioned to the focal distance of the lens, (affected also in some degree by the other humours), that the image of an object is formed accurately on the surface of the retina: accordingly, when the coats are cut from the back of the eye, the picture of a luminous object held before the pupil is seen exquisitely minute and distinct on the bottom of the eye.

While these humours have each its distinct character, they possess, in proportion to their density, different powers of refracting the rays of light. This has the still farther good effect of correcting the aberration of the rays and giving the truest colours, as well as the most correct image of the object presented to the eye.

If the lucid anterior part of the eye be formed too prominent, or if the lens of the eye have too great a degree of convexity, or, lastly, if the size of the ball of the eye, and the diameter of the vitreous humour in the axis of the eye be unusually great, then the person does not see distinctly; because the powers of the humours, in concentrating the rays of light, are too great, and the image of the object is not formed accurately on the retina, but before it. Thus, in fig. 7., the convexity of the cornea, the lucid anterior part of the eye, or the focal powers of the lens, being too great for the length of the axis of the eye, the image is formed at A before the rays reach the surface of the retina; and after coming accurately to the point, they again begin to diverge; which diverging rays, striking the surface of the retina, give the indistinct vision of a near-sighted person. But as this indistinctness of vision proceeds from no opacity, but only the disproportion of the convexity of the eye to the diameter, the

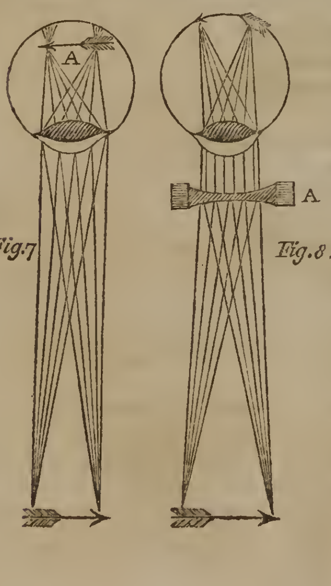


Fig. 7 Fig. 8.

defect is corrected by the concave glass, A fig. 8.; for, the effect of this glass being the reverse of the convex, it causes the rays to fall upon the surface of the eye, so far diverging from the perpendicular line, (which is exemplified in fig. 1.), as to correct the too great convergence caused by the convexity of the humours. But, when a near-sighted person has brought the object near enough to the eye to see it distinctly, he sees more minutely, and, consequently, more clearly; because he sees the object larger, and as a person with a common eye does, when assisted with a magnifying glass or convex lens.

The near-sighted person sees distant objects indistinctly; and as the eye, in consequence, rests with less accuracy upon the surrounding objects, the piercing look of the eye is diminished, and it has a dulness and heaviness of aspect. Again, the near-sighted person knits his eye-brows, and half closes his eye-lids: this he does to change the direction of the rays, and to correct the inaccuracy of the image, in a manner which may be understood by the following analogy. If we make a card approach a stream of light passing through the window, it will so attract the rays of light, as to extend the margin of the figure of the circular spot of light upon the wall. In the same way, when a stream of light, proceeding from an object towards the eye, is made to pass through a small hole, the circular margin of the hole so attracts the rays, as to produce the same effect with the concave glass; by causing the rays to take a direction outward, as if proceeding from a nearer object, the image is carried farther back from the lens; and when a near-sighted person peers through his eye-lids, it makes the rays impinge accurately upon the retina*.

The effect of old age, is gradually to reduce the eye to a less prominent state, and, consequently, to bring it to the reverse of the near-sighted eye.

From the decrease of the humours, and the lessened convexity of the cornea, the image of objects is not formed soon enough to impinge accurately on the retina, the rays tend to form the image behind the retina, as we see in fig. 9.

* Short-ſightedneſs may be produced by accidents. Sometimes I have known it produced by a piece of glaſs ſticking in the cornea, and cauſing great inflammation. Dr. Briggs mentions the caſe of an old man, who had long uſed ſpectacles, becoming ſuddenly ſhort-ſighted, by catching cold, and he was afterwards enabled to read the ſmalleſt print without glaſſes. In general, however, it is by ſome accident, and often late in life, that we become ſenſible of being ſhort-ſighted; and, in this caſe, men are very apt to attribute the defect to ſome particular occurrence.

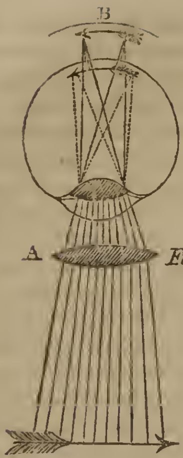


Fig. 9.

In this figure, we have the effect of old age on the humours represented; without the intervention of the glass A, the rays have a direction which would form the image at some distance beyond the retina, as at B. But by the convex glass A, (which is of the nature of the common spectacles for old people,) the direction of the rays of light is so corrected, that the image falls accurately on the bottom of the eye.

We understand, then, whence these opposite defects of sight arise; that, in old people, objects cannot be seen distinctly when near, and, in short-sighted people, they cannot be seen distinctly when at a distance. We see, also, why old age corrects short-sightedness by gradually reducing the convexity of the eye, enabling the person to see objects farther removed, until, by degrees, he comes to see perfectly at the distance most convenient for the common affairs of life.

It has been, by some, thought extremely difficult to account for the image appearing to us, as it is in nature, erect, since it is actually figured on the bottom of the eye in an inverted posture: but the terms above and below have no relation to the image in the bottom of the eye, but to the position of our bodies and the surrounding things. When I look to a tall man's face, I direct my eyes upward; I observe his situation, as it relates to an ideal area before my eye, or to a space in the sphere of vision.

When an object approaches towards the eye, the diameter of the picture on the retina increases in the same proportion as the distance between the eye and the object decreases; and, consequently, it decreases in the same proportion as the distance increases. But the degree of brightness of the picture of an object on the retina continues the same at all distances, between the eye and the object, unless some of the rays of light are interrupted in their progress; for, as the advancing object becomes bright, it increases doubly in length and breadth, or quadruply in surface. The faint appearance of remote objects, therefore, is occasioned by the opacity of the atmosphere.

There is nothing more astonishing in the structure of the eye, than the sensibility of the expanded nerve, as proved by the extent of the changes or degrees of light which illuminate

visible objects ; or the great degree of light which the eye can bear, and the low degree of light at which objects are visible. Thus, the proportion betwixt the degrees of light illuminating an object by the sun, and by the moon, at any equal altitudes, is calculated at 90,000 to 1 *. Again, by M. de la Hire's calculation, we see the sail of a windmill, six feet in diameter, at the distance of 4000 toises. The eye being supposed to be an inch in diameter, the picture of this sail, at the bottom of the eye, will be the eight thousandth part of an inch, which is the 666th part of a line, and is about the 66th part of a common hair. This gives us an idea of the minuteness of the structure of the optic nerve.

The pupil of the eye is formed by the central perforation in the iris or curtain, which hangs before the lens. This body having muscularity, is moveable ; it dilates or contracts the hole or pupil, transmitting the rays so as to adapt the diameter of the stream of light, darting into the eye, to the intensity or degree of light. If a body is illuminated but faintly, the pupil is (insensibly to us) enlarged, and a greater quantity of the rays are allowed to be transmitted to the retina. But as the convexity of the pellucid part of the eye, and the concentrating powers of the lens, remain the same, the size of the image is not altered by this dilatation of the pupil, but only the strength of the image or picture in the bottom of the eye is increased.

We understand that the rays of light are refracted, when they pass out of one medium into another of different density.—For example, the rays of light are refracted towards the perpendicular line, when they enter the cornea of the human eye ; but they will be refracted in a very small degree in entering the cornea of fish, because the aqueous humour is of the same density with the fluid from which the rays of light are transmitted ; accordingly, the cornea of fishes is not prominent : this would limit their sphere of vision, were not the flatness of the cornea counteracted by the prominence of the whole eye, and the more anterior situation of the crystalline lens ; a large pupil and long diameter of the eye we shall afterwards find to be necessary to the distinct vision of fishes.†

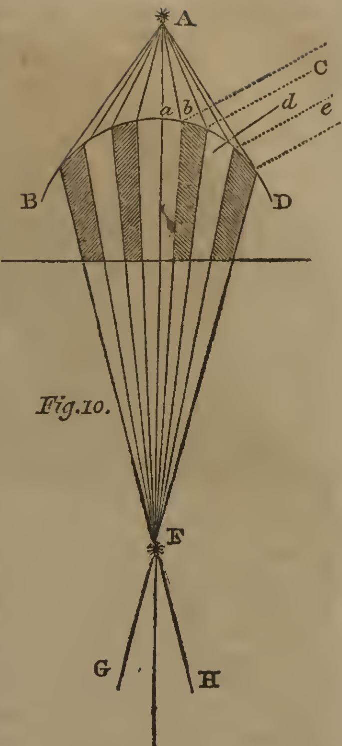
It is natural, on the present occasion, to inquire into the effects of the several humours of the eye, in producing in those

* See Smith's Optics, vol. i. p. 29.

† Neither fiſh out of water, nor other animals within water, can ſee an object diſtinctly. Divers ſee objects as an old man would do through a very concave glaſs put near to the eye ; and it has been found, that the convexity of ſpectacles for divers in the ſea muſt be that of a double convex glaſs, equal on both ſides to the convexity of the cornea. The neceſſity of this is plain ; the aqueous-humour being of the ſame denſity with the water, there is in it no refraction, and this deficiency muſt be ſupplied.

who are short-sighted, the obscurity arising from the double appearance of small and shining points. This is prettily explained by Jurin, upon Sir Isaac Newton's principle, concerning the fits of easy refraction and reflection of light.

The horns of the new moon, or the top of a distant spire, or the lines upon the face of a clock, appear double or triple, and sometimes much more multiplied, to a short-sighted person.—The same appearance will be given when an object is held too near the eye, for perfect vision. If the light is seen through a narrow slit in a board, and the board is brought nearer to the eye than the point of distinct vision, the aperture will appear double, or as two luminous lines, with a dark line between them; and as the distance is varied, two, three, four, or five dark and luminous lines will be observed. There are many such deceptions in viewing luminous bodies; all of them proceed from the same cause, which is this:—Before Sir Isaac Newton's philosophy was acknowledged, it was the received opinion, that light was reflected from the surface of bodies by its impinging against their solid parts, and rebounding from them like a tennis-ball when struck against a hard and resisting surface: further, as they saw that part of the rays of light were in glass reflected, and the rest transmitted, they conceived that part entered the pores of the glass and part impinged upon its solid parts. But this does not account for the refractions which take place when the rays have passed the glass, and are about to be transmitted into the air, they cannot find solid parts to strike against in entering the air, for the refraction of the light is greater in passing from the glass into the air, than from the air into the glass; and if water be placed behind the glass, the refraction of rays passing out from the glass is not increased but diminished, by this substitute for the rarer medium of the air. Again, when two glasses touch each other, no refraction is made in rays passing from the one into the other. To explain this, Sir Isaac Newton taught, that in the progress of rays of light, there is an alternation of fits of easy transition or reflection; or, in other words, that there is a change of disposition in the rays, to be either transmitted by refraction, or to be reflected by the surface of a transparent medium. Jurin illustrates this opinion, and its application to our present purpose, in this manner.



Suppose that A B D, and B D F, are mediums of different density, and that their surfaces are interceded by the line B D; again, let A be a pencil of rays, which, issuing from this point, falls upon B *a* D, as the refracting surface B *a* D is convex, and no two points of it, from *a* to D, are equally distant from the source of the rays A; and, as the rays of light, in their progress, alter alternately from the fit of refraction to the fit of reflection, they must be in part refracted to the focus F, and reflected in the direction of the dotted lines C *e*. Thus, if the ray A *a* happens to be in disposition to pass through the medium B D F, it will pass on towards the point F. If the next ray A *b* should be in no fit to be transmitted, because, being in a degree farther advanced from its source A, it has changed to the fit of reflection, then it will not be refracted towards the focus F, but reflected off towards *c*; but, again, the ray A D being advanced farther from its source, it will impinge upon the surface B D, during its disposition to refraction, and will concentrate its beams at F; and so with all the others, alternately reflected and refracted.

The consequence of this obstruction to the equal refraction of light, is, that the image formed at F is feeble; but still it is distinct and perfect; because the transmitted rays are regularly concentrated, and form the proper focus. But if the converging rays should be received upon a plain before they arrive at the focus F, the reflected rays of light will have left spaces dark where they would have fallen by refraction, and, consequently, distinct luminous circles will be thrown on the plain: again, if the plain surface be opposed to the rays, after they have formed their focus, and are again dispersing after having crossed, the same unequal effect of light and dark circles will be thrown on it; though now, the rays of the right side of the pencil B D F, will form the left of the pencil F G H.

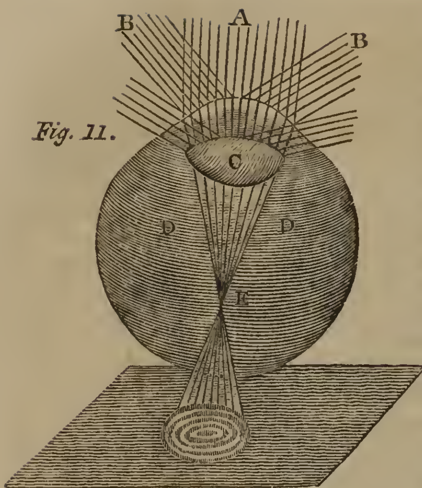


Fig. 11.

How the changeable state of the rays produces the indistinctness of the near-sighted eye, may be understood from this (11.) diagram.—When the rays A strike the convex surface of the cornea, part of them will be reflected from the surface of the cornea, in the direction of the lines B B, when they will consequently strike upon the convex surface of the lens in luminous rings, these rings will be still farther multiplied and diminished in diameter, in being in part transmitted, in part reflected, from the surfaces of the lens *c*, and vitreous humour D D. These effects of the alternate disposition of the rays for transmission and reflection would not be perceptible, did the converging powers of the cornea and lens bring the focus of the rays exactly to the surface of the retina; but as the focus is formed at E, some way before the retina, the rays have decussated and spread out again before they form the image upon the bottom of the eye. Instead, therefore, of forming an accurate image, they are spread out into concentric circles; or in a lesser degree, the person experiences a confused outline of the object, which becomes surrounded with several rings or false outlines.*

* By *fits of eaſy tranſition*, it was not meant by Sir Iſaac Newton that the ray muſt neceſſarily be tranſmitted through every pellucid medium, and at any obliquity of incidence, but only that the ray was more eaſily tranſmitted and more difficultly reflected; nor was it meant that during its *fit of eaſy reflection*, it was abſolutely incapable of being tranſmitted, but only more readily reflected than tranſmitted.

CHAP. II.

OF THE COATS OF THE EYE.

SPEAKING generally, and without considering the minuter divisions of anatomists, we may say, that there are three proper coats of the eye, viz. the SCLEROTIC COAT, giving strength; the CHOROID COAT, being the vehicle of the chief vascular structure of the eye; and the RETINA, or expanded nerve, being the organ itself. These are the proper coats of the eye; but there are others which may be called the partial or accessory coats, being those which do not completely surround the eye, viz. the ALBUGINEA and CONJUNCTIVA*. There are others, still, which are called capsular coats; and these are the transparent tunics which immediately surround the humours, as the capsule of the lens and pellucid membrane of the vitreous humour.

Although many of these coats may be capable of being divided by the art of the anatomist, either by the knife, by injections, which form extravasation between their layers, by maceration, or by the chemical action of fluids; yet it is better, in a general enumeration, to take a natural division and character, than to enumerate their several lamina.

OF THE SCLEROTIC COAT.

The sclerotic coat is so called from its hardness†. The sclerotica and cornea are often considered as one continued coat investing the eye; hence they say, the opaque and the lucid cornea. But, although these parts are actually in union, yet as they are really of so very different a nature, we must consider them apart, and treat at present only of the opaque white sclerotic coat.

The sclerotic coat is a strong, firm, and white membrane, consisting of lamellæ firmly attached and interwoven, and not capable of being regularly separated by maceration; it has the denseness of tanned leather. In firmness, whiteness, opacity, and the little appearance of vascularity, it more resembles the dura mater than any other membrane of the body.

In adults, the sclerotic coat is stronger and firmer, com-

* Colombier Sandifort Thes. Differt.

† Dura feu fclerotica; Vefalius, Ruyfch, &c.

paratively, than in the fœtus; the cornea less so. On the outer surface, it has (towards the orbit) a loose cellular membrane attached to it, which allows the motion of the eye-ball. Upon the fore part, it is invested by the tunica albuginea or tendinea. Upon its inner surface, it has a loose and soft membrane which connects it with the choroid coat.

In birds, and the tortoise, the posterior part of the sclerotic coat is thin; the fore part of it is split into laminæ, betwixt which there are interposed thin plates of bone*, while in fishes it is in part cartilaginous†, but thin and transparent, so that there appears a very beautiful spotted coat beneath it. There are also seen in the sclerotic of fishes little white granules like glands.

The vagina of the optic nerve can be separated into two laminæ‡; the outer one is observed to unite intimately with the outer part of the sclerotic coat, while the inner lamina of the vagina is continuous with its inner surface. The pia mater, too, says Zinn, when it has pierced the foramen in the sclerotic coat, along with the substance of the nerve, expands upon the inner surface of this coat, and extends even to the cornea, and forms one of its intimate laminæ. This must be only that part of the pia mater which invests the optic nerve, or, more strictly speaking, that membrane which stands in the same relation to the nerve that the arachnoid coat does to the brain; for the membrane, which sinks into intimate union with the nerve, accompanies it even in forming the retina§.

The sclerotic coat is the great support of the globular figure of the eye; it defends the more delicate internal structure from slighter injuries by its strength and from the progress of inflammation, by being of a structure but little vascular, and not prone to disease. That inflammation which we see to be

* Cuvier, vol. 1. p. 387.

† Morgagni Epiſt. An. xvi. 40. Cuvier, 388.

‡ Ruyſch, Zinn.

§ It may be well, in this place, to detail at once the opinions of the chief ſupporter of that ſcheme of the coats of the eye, which derives them all from the inveſting membranes of the brain and optic nerve. M. le Cat, in his *Traité des Sens* deſcribes them thus:—When the optic nerve has entered the orbit, the dura mater, which ſurrounds it, ſplits into two laminæ; the external one attaches to th orbit, and forms the perioſteum, the other forms the vagina of the nerve. In th angle formed by theſe, the muſcles of the eye ariſe. This continued ſheath of th nerve, he continues, expands into the globe of the eye, as the maſs of glaſs i blown into a bottle. The dura mater of the nerve is expanded into the corne (viz. ſclerotica). The ſecond envelope, or pia mater, forms two laminæ; th one is applied to the ſclerotic coat, and the other forms the choroid coat. Th choroid coat divides anteriorly, and forms the iris and ciliary proceſſes. The in ternal medullary part of the optic nerve forms the retina. Finally, "L'œil c tres evidemment l'extremité nerveuſe epanouie bourſouflée en bouton creux plein de liqueurs." p. 158.

so frequent in the eye, is not in the sclerotica, but in the adventitious coat, the conjunctiva. But in proportion as the sclerotic coat resists pressure and the progress of disease from without, it resists the swelling of the parts within when they become diseased, and gives the greatest torture.

Of what importance the entireness of the coats, and the uniform resistance of the humours of the eye is to the healthy state of the organ, will be afterwards examined.

OF THE CORNEA.

The cornea is so called, from being firm, transparent, and composed of laminæ*. It is the pellucid circle on the fore part of the eye, which seems variegated with colours; though this is a deception, owing to its perfect transparency. The circle of the cornea is, however, far from being regular; its margin is flat towards the nose.

The cornea consists of laminæ; betwixt which, there is interposed a cellular substance, filled with a perfectly pellucid fluid†. These cells seem, like the common cellular membrane of the body, to have a free communication with each other, so that the fluid freely exudes, and as quickly is imbibed, by maceration. The fullness of the cornea, with the perfect transparency of the fluid, gives a brilliancy to the eye, and is a sign of health; the reverse dims the eye, and, with the fallen features, accompanies ill health. Steno observed, and Petit confirmed, the fact‡, that the pores on the surface of the cornea exuded the fluid which fills the cells of the cornea; and that, after the surface was carefully dried by pressure, the moisture might be seen to form in drops upon the surface. The moisture can be thus forced out from the pores of either surface of the cornea§. This moisture becomes dull and clammy on the approach of death, and forms sometimes a pellicle over the cornea. The laxity with which the laminæ of the cornea are connected, may be, in some measure, demonstrated, by taking it betwixt the finger and thumb; we shall then find, that the layers can be made to glide very freely on each other. In the fœtus, and in young children, the cornea is of great thickness, and resists the point of the lancet or scissors. This resistance in the fœtus proceeds from a great degree of toughness, while, in the adult, the surface of the cornea is so hard, that I have often seen the point of the knife,

* "Cornu modo dura, & cornu inſtar in laminas dividi radique poteſt."—Veſſalius.

† Subſtantia ſpongioſa Valſalvæ.

‡ See alſo Hovius, p. 83.

§ Zinn.

in extracting the cataract, bend upon it. This turning of the elastic point of the knife is very apt to give a wrong direction to the incision; and, indeed, this occurred to me in my first operation.

There is a pellicle, or exceedingly thin coat, which, by maceration, can be taken off from the surface of the cornea. This is generally understood to be the conjunctiva continued over it. But I cannot help expressing myself as averse to the ideas of those anatomists who consider every membrane, which can be traced from another by dissection, as either derived from it, or in any way allied to it. This can surely serve no useful purpose, if, as here, the membranes differ in their use; are changed in their appearance; and have no similarity in structure, function, or diseases.

The membrane in fishes, analogous to the adnata, lies loose over the cornea; and, in serpents, it is thrown off from the cornea, with the scales of the body, and remains attached to the cast skin of the head; and in the fœtus calf, I have forced the blood in the vessels of the conjunctiva into vessels passing over the surface of the cornea.

By maceration, I have found, raised in the fluid, a very delicate and transparent membrane from the inner surface of the cornea; and, after long continued soaking, the whole cornea can be taken out of the sclerotic coat, like an optician's glass from its frame.

The cornea possesses great sensibility; although much of the pain, from hard bodies flying into the eye, is to be attributed to the motion of the eye-lids, and the great sensibility with which they are endued. When a splinter of glass or metal strikes and sticks in the cornea, inflammation is excited; in consequence of this, vessels carrying red blood strike into it or shoot over its surface in a new film of membrane*. Petit thought he observed first in a negro, and afterwards in a variety of instances, red lines in the cornea; which he conceived to be the anastamosing of vessels. There are, besides, says he, many circumstances which argue that there are blood vessels in the cornea. When the eye receives a stroke, there is often blood effused in its substance; abscesses, also, are found within it, and phlyctænæ on its surface; and in great inflammation of the eye, the cornea appears red; which, he supposed, must be produced by the same cause which makes

* I have found the ſpark from iron, in blackſmiths and maſons, buried in the cornea for ſeveral days, (ſome authors ſay months), without exciting pain or much inconvenience. I have alſo more than once picked a little black ſlough from the cornea, miſtaking it for a piece of iron, when it was only the conſequence of the injury.

the albuginea red, viz. the enlargement of its vessels, and the circulation of red blood. But we must not imagine, he continues, that, in the natural state, red blood circulates in the cornea; for the vessels are not to be seen with the microscope; nor are they penetrated by injection; nor do they appear in the fœtus; nor, when little abscesses are formed in the cornea; but only when violence has been done by a stroke upon the eye. In an eye in which the tunica conjunctiva was most minutely injected, as well as the internal vessels of the eye, I had resolved, carefully to examine the structure of the cornea; and after a long maceration, in which it had greatly swelled, I observed a set of vessels totally distinct from the extremities of the minute blood-vessels. The minute blood-vessels which were injected, stopt abruptly on the margin of the cornea. But these I now mention are particular; they are in great profusion, large, and perfectly pellucid; they are large towards the middle of the cornea, and diminish towards the margin. Their free communication formed a net-work deep in the thickened substance of the cornea. The size, perfect pellucidness, and intimate connection of these vessels, might perhaps incline one to call this a cellular structure.

Mr. Home* says, that an irritation on the edge of the cornea, and which includes the tunica conjunctiva, will produce greater inflammation, and more quickly, than a stronger excitement would produce on the centre of the cornea. This remark is probably from observation; but he adds, it is impossible that the vessels of the cornea, which naturally carry lymph only, or serum, can be made to carry red blood, unless the irritation extends to some neighbouring part supplied with red blood. This, certainly, is an erroneous idea; for the little opacities which surround spiculæ sticking in the cornea, the ulcerations on its surface, and little abscesses within its layers,† are the effect of inflammation of the part modified by its peculiar structure; and these will all take place while the margin of the cornea remains clear, and there is no apparent connection of inflammation, or of vessels with the conjunctiva.

Vessels attach themselves both to the inner and to the outer surface of the cornea; and when it becomes spongy and vascular in this way, little can be explained of its natural structure. Thus, the pannus and pterygium are membranes which stretch across and adhere to the cornea, while the iris frequently attaches to its inside. In this case, the cornea becomes spongy,

* Philos. Trans. 1797, p. 20.

† Viz. Onyx, unguis, an abfcefs between the laminæ of the cornea, from a fuppofed refemblance to the figure of a nail pared from the finger.

thick, and vascular; and, when cut, there is red blood in it;* and in staphyloma,‡ the iris is generally attached to the cornea. I have a preparation in which the form and character of the iris is entirely lost; it is extended into a reticulated membrane which lines the surface of the extended cornea.

OF THE CHOROID COAT.

The choroid is the vascular tunic of the eye; it is so called from its resemblance to one of the membranes of the secundines. It is the middle coat of the eye, lying betwixt the sclerotic coat and retina. Injections show it to consist of two layers of cellular tissue; and it has upon its inner surface a pigment, which being sometimes firm, might be taken for a membrane. It was Ruysch who observed this division of the choroid coat into two laminæ; and the inner one, his son called the tunica Ruyschiana: but of these hereafter.

Those anatomists who supposed the sclerotic coat to be the production of the dura mater, naturally concluded, that the choroid coat was derived from the pia mater; and as Ruysch found it to be divisible into two laminæ, so Sladius found the pia mater to consist of two membranes. It followed, that the one lamina of the choroid coat was the continuation of the tunica arachnoides, and the other of the pia mater; but this account of these membranes has no support from observation.— Betwixt the pia mater and choroid coat, there is no resemblance; the latter we shall find loaded with vessels; but these vessels are peculiar, and minister to a secreting surface. The pia mater in the brain, and optic nerve, is in strict union with the substance of the brain, and supports and nourishes it; but the choroid coat has no connection with the retina or expanded nerve.

There can be no better mark of distinction between membranes than their degree of vascularity, and particularly in the manner of the distribution of their vessels. The choroid coat is most particular in the distribution of its arteries and veins. The great arterial vascularity of the choroid coat is to be seen only after a very minute injection, and the venous vascularity after artificial or accidental infarction of the blood, or by a successful injection from the superior cava; although the ver

* PTERYGIUM, is a membrane which extends over the cornea from the canthi. PANNUS, is a congeries of blood-veſſels, which extends over the cornea, and is l[e]ſs uniform than the pterygium.

† STAPHYLOMA UVEA, a protruſion and opacity of the cornea: which, fro[m] the loſs of tranſparency and the general appearance of the tumour, is ſuppoſed [to] reſemble a grape.

great vascularity of this coat was known to our oldest writers, yet the appearance of these vessels, when empty, has deceived many. Morgagni* and Maitre-jean, have described fibres which they affirm to be distinct from the vessels, but which prove to be, in fact, the appearance presented by the collapsed vessels.

The great peculiarity of the choroid coat, is its being a secreting membrane; by which I mean, that the pigmentum nigrum which is applied to the medullary lamina of the retina being a secretion, the choroid coat has necessarily that peculiar structure of vessels which belongs to the secreting membrane. This structure has enabled anatomists to tear it into laminæ. For that part of the choroid coat next the sclerotic coat, is merely a vehicle of vessels and nerves, and is a tissue of them connected by very fine cellular membrane. The internal part, again, is organized into a secreting surface, and is the tunica Ruyschiana. I conceive, that the division into the choroid coat and tunica Ruyschiana, is warranted from the nature of the membrane, as the divisions of the coats of the intestines are.

Morgagni says, that from his earliest youth, he had many proofs that the choroid coat was not single in brutes; he asserts, also, that Franciscus Silvius and Guenellonius had demonstrated the double laminæ of this membrane before Ruysch.† Certain it is, that Ruysch was not so fortunate in ascribing a use to this tunica Ruyschiana. He supposed that it gives strength to the choroid coat, and, by bringing a greater afflux of arterial blood, supplies the necessary heat to the otherwise cold humours.‡

Tapetum. The internal surface of the choroid coat has been long called tapetum, from its villous or fleecy appearance, when seen through the microscope. This surface in the adult is of a brown colour; in very young subjects it is red and bloody; and, when minutely injected, it is like scarlet cloth.—It is by this vascular surface or tapetum that the black pigment, which is laid under the expanded retina in the human eye, is secreted.

The PIGMENTUM NIGRUM. The pigmentum nigrum is the black or deep brown mucous substance which lies between the choroid coat and retina. It is of a nature to be washed away

* Morgagni Epiſt. Anat. xvii. 2.

† Idem. ibid. 3.

‡ Quod ad uſum tunicæ Ruyſchianæ attinet crediderim hanc tunicam inter ceteros uſus eſſe deſtinatam, non ſolum ad robur choroideæ, verum etiam ut a ſanguinis arterioſi majori copia requeſitus calor tribus humoribus natura frigidis conciliaretur. Ruyſ. Reſponſ. ad Chriſt. Wedelium, p. 14.

with a little water and a soft pencil.* This brown taint pervades the whole texture of the choroid coat. This matter is in immediate contact with the medullary pulp of the optic nerve. Its use is apparently to stifle the rays of light after they have impinged on the sensible surface of the retina; for we know that blackness is owing to the absorption of the light, as whiteness and colour are the reflection of it from the surface of bodies. The dark colour of the secreted pigment of the choroid coat is, in some measure, peculiar to those animals which see in the brightest light of day; but is wanting, or of a bright reflecting green or silvery whiteness, in such as prowl by night. The natural conclusion, therefore is, that the pigmentum nigrum subdues the intensity of the impression, while the reflecting colours of the surface in animals which see in the night, strengthens the effect of the light on the surface of the retina, by repelling it. As fishes have the other provisions for seeing in an obscure light, they have also this of the reflecting surface of the tapetum: as it is a secretion of the villous surface of the choroid, we see why it becomes somewhat deficient in old men, and sometimes wanting in the degenerate varieties of animals; when entirely deficient, the blood circulating in the vessels of the choroid coat gives a livid redness to the reflections from the bottom of the eye.†

Finally, in regard to the choroid coat, we have to understand that it consists of two laminæ: the outer, and that which is next to the sclerotic coat, being the proper choroid; the internal lamina, the tunica Ruyschiana: that on the surface of the tunica Ruyschiana, there is a pile or fleece, which is callec petum: and, lastly, that the secretion of this inner surfa a pigment, which, in the human eye, has the appropriate n of pigmentum nigrum; but, in many animals, it is of a si golden, or Isabella colour; though, in my apprehension colour, in all these varieties, depends still upon a peculi creted matter.

* I cannot conceive how this matter ſhould be confounded with the t or tapis, which, as the name implies, is the villous ſurface of the choroid Tapetum is, properly, cloth wrought with various colours; and the analc firſt uſed by the French Academicians, in their account of the diſſection o eſs. "The membrane which is put into the bottom of the eye, and laid on roides, which we call the tapetum, was of an Iſabella colour, intermixe greeniſh blue. It was eaſily ſeparable from the choroides, which remaine with its ordinary thickneſs, after that we had taken away the membrar forms the tapetum." The explanation of this, I ſuppoſe, will be found i Epiſt. An. xvii.

† As the pigmentum nigrum is a ſecretion, we ſhall not be ſurpriſed become deficient in the commencement of ſome diſeaſes of the eye. This by the poſſibility of ſeeing to the bottom of the eye: that is, the choroi comes a reflecting ſurface, and throws out the beams like a cat's eye. Obſer. and Enquiries, vol. iii. p. 124.

OF THE CILIARY PROCESSES.

The ciliary processes are formed of the anterior margin of the choroid coat; they give the appearance as if the choroid coat, at the anterior part, were folded inward to the margin of the crystalline lens; and, as if, to accommodate it to this sudden inflection, it had been plated, and not regularly contracted; at least, this is much the appearance of the circle of ciliary processes, when, after cutting across the eye, we look from behind upon the lens in its natural situation. In this view, we find the pigmentum nigrum of the choroid coat continued over the ciliary processes, which gives to them the appearance of the regular plicæ of the choroid coat, converging to the edge of the lens, and forming altogether a disk round it.

When the black paint on the ciliary processes is a little washed away, and when we attentively examine this part, we find the ciliary processes to be actually little oblong plicæ, which gradually arise from the choroid coat at the angle of its inflection, and terminate abruptly, approximating, but not attached, to the margin of the lens. When the paint is washed entirely away, the whole circle of these processes appears evidently to be the continued choroid coat.

When not injected, the ciliary processes are pale and loose; but when minutely injected, they take a perfect scarlet colour; they resemble, in their uninjected state, the valvular-like doublings of the villous coat of the stomach and intestines. Before the choroid coat is inflected towards the lens, in the form of ciliary processes, it forms a firm adhesion to the sclerotic coat near the circular margin of the cornea, and at the same time is united firmly to the root of the iris. From this, the processes tend inward, and a little backwards; and are, at their internal extremities, detached from the iris; nor are they attached to the margin of the lens, but are loose and floating.

When the vitreous humour and lens fall out from the anterior segment of the eye, we find that the plicæ or ciliary processes have left their impression on the anterior surface of the vitreous humour, and also on the intermediate expansion of the retina which extends before the membrane of the vitreous humour. This circular impression of the ciliary processes is called by Haller, striæ retinæ subjectæ ligamento ciliari.* I have called this impression HALO SIGNATUS, because it is formed of a circle of radiations, formed by the impression of the ciliary processes, and is not peculiar to the retina, but the retina again makes

* Fafcic vii. icon. ocul.

its impression on the membrane of the vitreous humour. The furrows and doublings of the anterior part of the retina, formed by the impression of the ciliary processes, Dr. Monro has called the ciliary processes of the retina; but, for my part, I think this a term likely to confound and mislead a student; and we might as well speak of the ciliary processes of the vitreous humour, or of the membrane of the vitreous humour, since they also take the impression of the ciliary processes.*

When the vitreous humour and lens are taken out of the coats, we see also that the ciliary processes have left the stain of the fuliginous paint.† This it is necessary to remark, since I have seen students confound this mark with the ciliary processes themselves. The ciliary processes are of a most elegant vascular structure. Their contorted arteries are beautifully represented in Zinn's figure. He traces them from the extreme branches of the choroid coat; but, of their veins, he says nothing further than that they are continued from the branches of the vasa vorticosa, or veins of the choroid coat. The points of the ciliary processes are not attached to the lens, but float loose in the posterior chamber of the aqueous humour;‡ but at a little distance from their points, they adhere to the retina, where it is continued over the anterior part of the vitreous humour. Through this attachment only, are they connected with the lens; for, as we shall find presently, the retina (as a membrane, but not as the sensible retina) is continued over the crystalline lens.§

The ciliary processes, collectively, form a circle round the lens, which I call corona ciliaris. This circle forming a perfectly opaque partition, which stifles all rays that might otherwise be transmitted by the side of the lens. The corona ciliaris, or ciliary circle, no doubt, serves at the same time as a connexion between the outer and strong coats of the eye and the transparent coats and humours; for, it is to be observed, that, excepting the connexion which naturally exists betwixt the optic nerve and retina, this slender hold which the ciliary processes take of the expanded retina, is the only attachment betwixt the humours of the eye and the proper coats.

* Winslow uses the term sulci ciliares, for the impression on the vitreous humour. Zinn calls this corona ciliaris, after Camper; he describes them well, p. 75.

† See Morgagni Epist. Anat. xvii. n. 13, and Ruysch also, "Nonnulli pro processu ciliari agnoscunt pullas pigmenti nigri reliquias, membranulæ tenuissimæ humoris cristallini & vitrei, & quasi fibres mentientes oculo sc. aperto, humoribusque exemptis; hæ autem nil sunt nisi avulsæ particulæ pigmenti nigri." Ruysch. Thes. An. ii. Ass. 1. No. xv.

‡ This was demonstrated in a particular manner by Ruysch and Morgagni.

§ Zinn and other later writers have entertained the idea, that the adhesion of the ciliary processes to the membranes covering the vitreous humour is by a kind of gluing, rather than a union by cellular membrane. See Zinn, p. 75.

In regard to the names appropriated to this part of the eye, there is more confusion than it is possible to believe. It is necessary to attend to this ambiguous use of terms, else we shall be in danger of misunderstanding our best authors. Vesalius considers the whole as a septum betwixt the vitreous and posterior chamber of the aqueous humour; but he seems to find much difficulty in giving it an appropriate name.* Fallopius and Morgagni† use the term CORPUS CILIARE for the whole circle of the processes, and in the same sense that I have ventured to use corona ciliaris. It is a name which conveys the idea neither of the shape nor of the substance of the thing meant. Ruysch makes great confusion by his use of terms; the corona ciliaris, or ciliary body, he calls the ligamentum ciliare; and the lines on the back surface of the iris, he calls processus ciliaris musculosus; or, rather, he means by this, the straight fibres of the iris.‡ Duverney, with Ruysch and Winslow, following Fallopius, calls the corona ciliaris also ligamentum ciliare. But the ciliary ligament is used by others in a widely different sense, viz. for the circular root of the ciliary body and iris, the anulum album cellulosum, or the frenula membranosa of Zinn. By Hovius, what I have called halo signatus, is called ligamentum ciliare. In Haller's fifth figure of the eye, this circular root of the ciliary processes, is called orbiculus ciliaris. Maitre-jean, Haller, and others, call the whole body, or corona, the ciliary circle. M. Ferrein, l'anneau de la Choroide, and M. Lieutaud, denominated the ciliary processes "rayons ciliares," and the root of the corona ciliaris and iris, "plexus ciliaris."

* "Neque mihi ullum occurrit nomen quod ipſi aptius indam quam tunicæ: aut ſi voles, interſtitii vel ſepti inter vitreum humorem & eum quem albugineum nuncubamus repoſiti." Veſal. vol. i. p. 558.

† Epiſt. Anat. xvii. 11.

‡ Ruyſch has this expreſſion: "Ligamentum ciliare neutiquam eſſe conſiderandum tanquam muſculum ad pupillæ et humoris criſtallini motum deſtinatum, totumque hoc negotium perfici a proceſſu ciliari ut et a circulo muſculari poſterius in confinio pupillæ ſito." Thes. Anat. ii. xv. See also the explanation of fig. iv. of this Theſaurus, where we have "Iris enim eſt facies exterior, proceſſus lig. ciliaris facies interior.

CHAP. III.

OF THE IRIS.

THE iris is the coloured circle which surrounds the pupil, and which we see through the transparent cornea of the eye. It is a membrane hung before the crystalline lens*. It is as if perforated in the middle; and this hole in the middle of the iris is the pupil; and through the pupil only can the rays be transmitted to the bottom of the eye. When we hear of the dilatation and contraction of the pupil, we have to understand the action of the iris, which, by possessing the power of contracting and relaxing, holds a controul over the quantity of light transmitted to the bottom of the eye. For by the extension of this membrane, the diameter of the pupil is diminished, and, by contraction of the membrane, it is dilated. This motion of the iris, and, consequently, the size of the pupil, is connected with the sensation of the retina; by which means, in disease of internal parts of the eye, it is often an index to us of the state of the nerve, and of the possibility of giving relief by operation.

The iris and corona ciliaris, or ciliary processes, are, in general, considered as being the two laminæ of the choroid coat continued forward and split: the internal lamina of the choroid forming the corona ciliaris, and the outer one forming the iris. The former I was willing to consider as the anterior margin of the choroid coat, because it has no distinction in its structure from that coat; but the iris I cannot consider as the continued choroid coat: in the *first* place, because I have found it fall out a perfect circle by maceration; *secondly*, because it has no resemblance in structure to the choroid coat; and, *chiefly*, as by its power of contracting, it shows a widely different character from any of the other membranes of the eye.

The outer surface of this circular membrane gives the colour to the eye during life; and from its beautiful and variegated

* Winſlow and Haller, and moſt of the old anatomiſts, call this UVEA; but moſt of the modern anatomiſts follow Zinn and Lieutaud, in calling it iris; though Lieutaud and others called the anterior ſurface only iris, while they ſtill continued to call this perforated membrane choroides, or uvea. See Lieut. p. 117. Again, others call the poſterior ſurface of the iris uvea, from its likeneſs to the dark colour of a raiſin; and the word iris is borrowed, I ſuppoſe, from the varied colours of the rainbow.

colours, it has gained to the whole membrane the name of iris. Haller and Zinn, nearly at the same time, explained the cause of this coloured iris, which had been, till then, supposed to be occasioned by the refraction of the light amongst its striæ and fibres.

When this membrane is put in water, and examined with the microscope, its anterior surface is seen to be covered with minute villi. The splendid colouring of the iris proceeds from the villi; but by beginning putrefaction, the splendid reflection fades, as the brilliant surface of the choroid of brutes is lost by keeping. For this reason, I imagine the colour and brilliancy of the iris to depend on the secretion of these villi. But the colour of the iris depends, in a great measure, on the black paint upon its posterior surface shining through it; and the black and hazel-coloured iris is owing to the greater degree of transparency of the iris, which allows the dark uvea to shine through it.

The iris is acknowledged to be the most acutely sensible part in the body. We have, then, to expect in its composition, muscular fibres, and to account for its acute irritability and sympathy, by a profusion of nerves: again, as the power of the muscular fibre, and the sensibility of the nerve, are both, in some measure, indebted to the circulation of the blood, we may expect to find also a profusion of vessels in the iris. In all these respects, we shall find the iris to be an object of admiration.

OF THE MUSCULAR FIBRES OF THE IRIS.

It is evident from a note, under the head corona ciliaris, that Ruysch had observed two sets of muscular fibres in the iris; for, under the name of ciliary ligament, he describes a set of radiated fibres which go from the ciliary processes towards the circular margin of the pupil: he observed also, the circular or orbicular fibres which run round the margin of the pupil. Winslow says, that between the two laminæ of the uvea (viz. iris) we find two thin planes of fibres, which appear to be fleshy: the fibres of one plane orbicular, and lying round the circumference of the pupil, and those of the other being radiated; one extremity of it being fixed to the orbicular plane, the other to the great edge of the uvea. Zinn describes, with much minuteness, radiated fibres (on the anterior surface of the iris), but does not consider these as muscular fibres; and he confesses, that he could not observe the orbicular muscle which Maitre-jean and Ruysch had painted. Even in owls and other creatures, having a strong iris, he could not discover

an orbicular muscle ; nor were Haller and Morgagni more successful in this investigation*. Wrisberg also affirms, that no muscular fibres could be seen in the iris of the ox. Dr. Monro, on the other hand, adheres to the opinion of the muscularity of the iris: he describes minutely both the radiated and sphincter fibres. Wrisberg and others have thought they found sufficient proof against the muscularity of the iris, in the fact of its not contracting when the light falls upon its surface. To this Dr. Monro answers, that the colour or paint upon the iris must, like a cuticle, prevent the light from irritating the iris. I cannot think that this circumstance should prevent the excitement of the iris. The retina is in a peculiar manner susceptible of the impression of light; but we cannot wonder that light should not stimulate a muscle to contraction, when we have every proof that it has no effect on the most delicate expanded nerve of the other senses.

That the iris is to be affected only through the sensation of the retina, or perhaps rather the effect communicated to the sensorium, we have sufficient proof. I have, in couching, repeatedly rubbed the side of the needle against the iris without exciting any motion in it: I have seen it pricked slightly by the needle without its showing any sign of being irritated ; nay, what was too a convincing proof, I have seen it cut by falling before the knife in extracting the cataract: in this last instance, far from being stimulated to contraction, it hung relaxed†.

It is evident, then, that no common stimulus, immediately applied to the iris, has any sensible effect in exciting it to contraction ; and that it is subject only, in a secondary way, to the degree of intensity of light admitted to the retina. The movement of the iris is in general involuntary ; but terror and sudden fright affect it. In some animals, particularly in the parrot, it is a voluntary muscle‡. As an object, upon which we look, approaches the eye, the pupil contracts, which is an effect of the increasing intensity of the light reflected from the object ; for, as the object advances, it fills a greater space in

* See Zinn, p. 89 and 90. Morgagni. Epist. Anat. xvii. § 4. Haller and Ferrein attribute the motion of the iris to an afflux of humours in its vessels.

† This fact destroys the hypothesis of M. Mery, of the Royal Acad. of Sciences, that the straight fibres of the iris are little cavernous bodies, and that the action of the light upon the retina swelled and elongated them so as to cause the diminution of the size of the pupil; for, by this cut, they must have fallen from their erected state, and contracted so as to have dilated the pupil. See Acad. Roy. des Sc. 1704, mem. p. 261.

‡ When a cat is roused to attention, as by the scratching of a mouse, it dilates the pupil, which allows a stronger impression on the bottom of the eye; nay, whenever puss struggles violently to get loose, the pupil dilates, which may sufficiently account for M. Mery's cat having her pupil dilated when he plunged her under the water. See Acad. Roy. des Sc. 1704, mem. 261.

the sphere of vision, and of course more rays flow from it into the eye.

NERVES OF THE IRIS. The iris is supplied with nerves in great profusion. They are derived from the long ciliary nerves which run forward betwixt the cornea and choroid coat towards the common root of the corona ciliaris and the iris. They there divide, and are seen to pass in numerous branches into the substance of the iris. In the substance of the iris, the branches of the nerves, from their extreme minuteness, are soon lost amongst its pale fibres.

BLOOD-VESSELS OF THE IRIS. I have had preparations which showed so great a degree of vascularity in the iris, that I was ready to believe its action to be produced entirely by a vascular structure ; but when, on other occasions, my admiration was excited by the profusion of nerves, and I was led to observe that in the former instances they had been obscured by the injection, I could not but allow that the muscular fibres might have been obscured as the nerves were.

There are four arteries sent to the iris : two long ciliary arteries which take a long course on the outside of the choroid coat, and two lesser and anterior arteries which pierce the ligamentum ciliare from without. These arteries approach the root of the iris at four opposite points, and branching widely form a vascular circle round the root of the iris, viz. the larger circle of the iris. From this circle branches pass off, which run with a serpentine course, converging to the edge of the iris : here they again throw out inosculating branches, which form a circle surrounding the pupil, but at some little distance from the edge of the iris—this is the lesser circle of the iris. From this lesser circle there again proceed minute branches towards the edge of the iris*.

The VEINS, which intermingle their branches with these arteries, pass some of them into the vasa vorticosa of the choroid coat, and others take a long course betwixt the choroid and sclerotic coat, accompanying the ciliary nerves, whilst some branches pierce the sclerotic coat at the root of the iris, and become superficial upon the fore part of the eye.

* See Ruyſch Epiſt. Anat. prob. xiii. p. 31.

CHAP. IV.

PRACTICAL REMARKS DEDUCED FROM THE STRUCTURE OF THE CHOROID COAT AND IRIS.

THE choroid coat, ciliary processes, and iris, being the most vascular parts of the eye, are frequently the seat of disease, and administer to the disorder in all violent internal affections of the organ. I had always conceived these parts to be chiefly active in the carcinoma of the bulb of the eye, and I had lately an opportunity of observing this in dissection. In this disease, there is first deep pain in the eye, from the inflammation and disorder of the vascular coats; and often the effect of the increased action, within the eye, is known from its effects in enlarging the veins on the surface of the eye-ball.— These vessels being active in their natural state, are very apt to become diseased when disturbed in their action; and although we frequently see the eye quite sunk, yet, when it is burst, and the vascular coats are protuberant, a cancerous state of the eye is to be dreaded.

When the eye is hurt by a blow; when inflammation spreads from the cornea to the iris, in consequence of a small-pox pustule; when an ulcer of the cornea, or an incision of it does not heal quickly, but allows the aqueous humour to distil out, and consequently the iris to fall in contact with the cornea; the iris adheres, and often forms staphyloma. Thus we find staphyloma to follow the operation of extraction, in consequence of the iris protruding and adhering to the wound: again, in staphyloma from small-pox, by the adhesion of the iris to the cornea, while the cornea is extending and perhaps bursts, the iris mixes with the cornea, and gives the ugly black and mixed colours of this disease. I have a preparation in which the cornea had greatly dilated; the iris is extended like a black net-work upon the inner surface of the cornea; and in the usual place of the iris, the ciliary processes are to be seen. The iris adheres also to the capsule of the lens, which is behind it, and, as we shall presently see, close upon it. I saw it in one instance, adhering so strongly to the cataract, that, in attempting to depress the cataract with the needle, the edge of the iris was turned over and depressed with the needle, and the regularity of the pupil was destroyed; of course, here,

there could be no permanent depression, without previously cutting this adhesion.

It was at one time believed, on the authority of many excellent anatomists, that the vessels of the iris were colourless, and did not circulate red blood: after what has been said, it is scarcely necessary to mention the fallacy of this opinion.* I have seen the iris cut and bleeding, though not profusely as I expected; the small quantity of blood soon coagulated into a dark speck, while I expected it should have been effused in the aqueous humour.

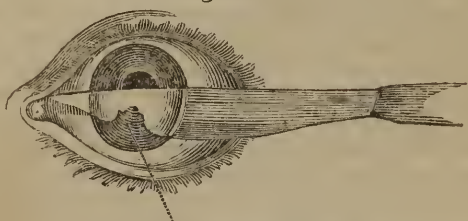
There is a circumstance in the operation of extracting the cataract which I have seen little attended to, and yet it is sufficiently evident. When the cornea has been cut, operators, disappointed in not finding the cataract protruded, keep the eye staring in the light, and press the ball of the eye; but while the eye is thus exposed to the excitement of the light, the pupil is contracted, and the lens propelled by the action of the muscles; and, still more, by the pressure made on the eye-ball, is in danger of bursting through and tearing the iris. The best operators have been in the custom of shutting the eye-lids the instant the incision was made in the cornea; by this means, the eye is for a time supported in some degree during the violent spasm of the recti muscles, and the iris being allowed to dilate, the lens is protruded into the anterior chamber of the aqueous humour through the pupil, and is ready to slip from under the cut cornea, when the eye-lids are again opened. By this means, if the incision of the cornea is of the proper extent, the lens is not *extracted* but is *protruded*, by the action of the muscles of the eye.

It is very necessary for us to remember, that all the parts of the eye in themselves extremely delicate, are kept in their relative places, not by adhesions, but by the complete support they derive from the globular form of the eye, and by the strength of the outer coat or sclerotic and cornea. To this, it is particularly necessary to attend, in the operation of the extraction of the cataract; for, as soon as the aqueous humour is evacuated, the uniform resistance of the coats of the eye is destroyed, and the muscles surrounding the eye-ball force all the humours towards the incision. It is this circumstance which brings the iris into great danger of being cut when the knife is too narrow to make the incision, at once, by pushing it through the cornea with an uninterrupted motion of the fingers. For,

* Dr. Monro, in treating of this ſubject, mentions his having ſeen a net-work of veſſels covered with paint darker than that of the iris, and extended from the iris upon the ſurface of the lens; and, in another inſtance, a net-work of filaments paſſing quite acroſs the pupil. See his Diſſertations, p. 108.

when the knife is not broad enough to cut itself out by moving it uniformly along, the aqueous humour escapes in the endeavour to cut downwards, and the iris is protruded so as to fall under the edge of the knife; nay, with a good knife, and of a shape to cut itself out, and at the same time adapted to make a cut in the cornea sufficient to allow the escape of the lens, I have seen, in consequence of a hesitating manner of introducing the knife, the aqueous humour suffered to escape. Now, observe the consequence of this:—The lens being pushed outwards by the contraction of the muscles on the eye-ball, towards that point at which the continuity and consequent uniform resistance of the coats were broken, the margin of the iris was forced under the edge of the knife and cut, as I have here represented.

Fig. 12.



The margin of the Iris fallen before the edge of the knife and cut.

A very particular effect of this cut upon the margin of the iris is to be observed.—When the incision has been happily done, the lens is protruded uniformly through the pupil; but when the iris was cut, as now explained, the edge of the lens, opposite to the part of the iris which was cut, was forced forward; the lens was turned side-ways, without being entirely displaced; and a great part of the vitreous humour was allowed to escape.

CHAP. V.

OF THE RETINA, AND DIGRESSION CONCERNING THE SEAT OF VISION.

THE term retina has, in a modern publication, been objected to, as improperly applied to the inner coat of the eye.—Such a term, it has been said, may well be applied to the nerve expanded on the lamina spiralis of the cochlea, because it is there formed into an intricate plexus by innumerable joinings and separations of its component parts; but used for the expanded nerve of the eye, the term retina is thought improper.* We must look for the resemblance, however, which justifies this term, not in the medullary matter of the nerve, but in its vessels. "Hanc figuram egregie repræsentat dicta tunica retina cum arteriolæ ceracea materia sunt repletæ."†

The retina is the expansion of the optic nerve; the immediate seat of sensation, and the most internal of those membranes which are called the coats of the eye. It has been already observed, that there is a distinction betwixt a nerve in its course from the brain to the organ of sense, and where it is actually expanded and adapted to the reception of the external impression. Before the optic nerve has perforated the sclerotic coat of the eye, it is surrounded with a firm sheath; and its substance is evidently composed of bundles of fibres, though not so coarse, yet like those of the nerves in the other parts of the body. The opacity of the nerve makes it have little the appearance of vascularity, but when the body of the nerve is made transparent, it becomes like a red cord; so necessary is it that the medullary substance of the nerve be supplied with blood.

The stronger sheath which surrounds the body of the optic nerve is loose, and may be separated into lamellæ. There is a more delicate membrane which immediately adheres to the surface of the nerve; and its substance is formed into the minute fasciculi which give it the fibrous appearance by a still firmer intertexture of membrane. This interwoven membrane proceeds, with the retina, into the eye; the other sheaths are re-

* Dr. Monro's 4to Treatiſes.

† Ruyſch. Epiſt. Anat. xiii. p. 14. Quemobrem ſervare adhuc retinæ, appellationem ſi non ex fibrarum ut certe ex vaſorum implicatione, &c. Morgagni Epiſt. Anat. xvii. § 43.

flected off, and unite with the sclerotic coat. Some little way from the back part of the eye, the arteria centralis retinæ pierces the sheath of the nerve, plunges into the centre, and passes into the eye along with it. If the optic nerve be cut near to the eye, the open mouth of this small artery may be seen; but if we make our section some way removed from the back of the eye, it will, of course, not be seen. The artery contracting and leaving a space in the centre of the nerve when thus cut, (or perhaps it was the open mouth of the artery itself,) was observed by the ancients, and by them called the porus opticus, because they were ignorant of this central artery of the retina.*

Where the optic nerve is about to enter into the ball of the eye, it is much diminished in diameter; it is contracted and condensed, and, at the same time, lays aside the strong coats. The proper nerve then perforates a cribriform lamina in the sclerotic coat. Within the eye, the filaments seen in the nerve are no longer distinguishable; but from the extremity of the nerve the fine web of the retina is produced.

The LAMINA CRIBROSA, and the delicate fasciculi of the optic nerve, are shown in this manner: after making a section of the eye, wash away the retina from the extremity of the optic nerve, and also the choroid coat; then press the optic nerve betwixt the finger and thumb, when the pulp of the nerve will be seen to protrude through the foramina in the sclerotic coat like white points. It is observed by Zinn, that, in doing this, there is a central foramen which remains unfilled up by the compression of the nerve. This is the hole perforated by the arteria centralis retinæ.† Where the threads of nerves are accumulated after passing these foramina, and before they are finally expanded into the retina, they necessarily form a small cone or papilla. This conical form of the extremity of the optic nerve is much more evident in some animals than in others; but in a section of the human optic nerve we may also observe it.‡

The retina is a membrane of the most delicate texture of any in the animal body: it is transparent in the recent state, and so soft, that it will tear with its own weight. In spirits and weak acids, it becomes opaque and firmer. It lies expanded over

* Porum opticum Herophilus et omnis ab ea antiquitas dixit, foramen nempe quod in diffecto nervo de vacua arteria fupereft. Hall. Arter. Ocul. Hift. p. 42.

† Zinn de oculo humano, p. 106. Com. Reg. Soc. Scient. Gotting. loc cit. About 30 foramina have been obferved in the lamina cribrofa. See Haller Fafc. de Arter. Oculi, p. 42.

‡ Zinn. " At the place which anfwers to the infertion of the optic nerve, we obferve a fmall depreffion, in which lies a fort of medullary button terminating in a point." Winflow, p. 78.

the vitreous humour, and contiguous, but not adhering, to the choroid coat, or its pigment. The retina does not consist merely of the expanded nervous matter, but has, in its composition, a very fine membrane, and many minute vessels. When the retina is macerated for a considerable time, the pulp of the nerve can be washed away, and there remains only the reticulated and delicate membrane which supports the vessels that nourish it. But though the pulp of the nerve may be dissolved, it cannot, by dissection, be freed from the membrane which supports it*.

I have a preparation which more resembles some of Ruysch's plates than any I have seen. In this preparation, the nerve being washed away, we may see distinctly the whole course of the arteria centralis retinæ. Of this preparation I have given an engraving, to show how plentifully this organ is supplied with red blood; from which circumstance we may learn the strict dependence of its function on the circulation, and deduce the derangement of the powers of vision, as a natural consequence of the disordered action of these vessels.

The soft medullary matter of the retina is towards the surface of the choroid coat, and forms there a lamina, which appears to me to be the surface of the nerve upon which the rays of light impinge†. The vessels of the retina run upon the surface contiguous to the vitreous humour‡. The arteria centralis retinæ is derived from the ophthalmic artery. It pierces the optic nerve, as we have already observed, and enters the eye through the porus opticus, to supply the retina. But the arteries of the retina do not always enter into the eye in one trunk; on the contrary, sometimes two or three branches

* "Poſſe vere medullarem retinæ laminam removeri ut vaſculoſum rete membranæ figuram retineat, alteramque ab altera integram detrahi ultra hominum artem poſitum eſſe videtur nec ulli unquam contigiſſe, legere me memini, etſi, deleta macerendo medulla, rete vaſculoſum laminam peculiarem referre videatur. Ex quibus omnibus elicio retinam eſſe tunicam ſimplicem, ex celluloſa conflatam: que vaſcula et ſubſtantiam medullarem ſuſtinet etſi duas diverſas oſtendat facies alteram vaſculoſam interiorem, alteram medullarem exteriorem." Zinn, p. 112.

† "C'eſt ſurtout dans les poiſſons qu'il eſt facile de diſtinguer et meme de ſeparer ces deux lames." Cuvier, tom, ii. p. 419.

The opacity of the outer ſurface of the retina prevents the vaſcularity from being apparent. Albinus, after a very minute injection, obſerved, that when he lifted up the choroid coat, the vaſcularity of the retina was not ſeen: "Autem de ea aliquid acuto ſcalpello ſubtiliter leviſſimeque deradens, mox conſpicio vaſa impleta multa quæ ſub medulla cujus nimirum portionem deraſeram latuerant." Albin. An. Acad. lib. iii. cap. xiv.

‡ Dr. Monro has theſe words. expreſſive of an oppoſite opinion: "The whole appears to be compoſed of an uniform pulpy matter, on the outer ſide of which chiefly veſſels are diſperſed, ſupported, I ſuppoſe, by a membrane the ſame or analogous to the pia mater." 4to Treatiſes on the eye, ear, &c.

pierce the lamina cribrosa*, and afterwards, two, three, or four principal branches, spread out on the circumference of the retina; from these, the ramifications are so numerous, that Ruysch describes them as constituting the membrane†. Corresponding with the arteria centralis retinæ in the adult, there are veins, the minute extremities of which, after forming connections with the veins of the corona ciliaris, run backwards on the inner surface of the retina in three or four distinct branches. These uniting into a trunk, perforate the lamina cribrosa, and become the socia arteriæ centralis.

Many have been led to believe, that the retina terminates forward on the roots of the ciliary processes, as others have conceived it to be continued over the fore part of the vitreous humour, and over the surface of the lens‡; but the most prevalent opinion is, that it terminates on the margin of the lens.

That the retina extends over the back of the lens, and receives there the impression of light, is very improbable; but that the membrane which supports the retina, is continued over the lens, is demonstrable. As I have just said, the retina, I conceive (with Albinus, M. Ferrein, and others), to consist of two distinct parts, viz. the medulla of the nerve, and a pellucid membrane supporting it; but, however reasonable this conclusion is, I cannot believe that these portions are to be separated by dissection. It is, by most anatomists, believed, that the retina passes forward betwixt the vitreous humour and ciliary body, and adheres to the margin of the lens. Now, as this adhesion is not a glueing together of parts, but a union or intermixture of membranous filaments, the interchange and mingling of fibres, we may safely say, that the membrane of the retina is continued over the lens, and forms part of its capsule. The opacity of the retina is diminished at the root of the ciliary processes, and disappears altogether at the margin of the lens; and here it is not only changed by becoming perfectly transparent and allied to the membranes of the humours, but it becomes also distinguishable from the opaque retina by a greater toughness and strength. The continuity of the retina with the capsule of the lens is more ap-

* Haller loc. cit. Morgagni Ep. Anat. xvii. n. 44. nor do they always pierce the centre of the nerve exactly. Morgagni.

† "Iteratis perſcrutiniis reperio oculis armatis arteriolarum extrema tam eſſe numeroſa & tam arcte ſibi invicem et intricate annexa ut peculiarem repreſentent membranulam ex arteriolarum extremis conſtitutam, cui connectetur dicta medulloſa ſubſtantia." Ruyſch Epiſt. Anat. xiii. p. 15.

‡ Many anatomiſts, Winſlow, Caſſobohm, Ferrein, Lieutaud, and Haller, have taught that the retina extends over the great convexity of the lens, or that it is inſerted into it. Galen believed it to extend over the lens. For an impartial hiſtory of opinions, ſee Morgagni Epiſt. Anat. xvii. 47. and Zinn, 114.

parent, when both membranes have become opaque by being immersed in spirits or vinegar, but more particularly when that opacity is produced by disease. In disease, I have found the veins of the retina running over the margin of the lens, and branching on its posterior convexity.

Where the retina lies betwixt the vitreous humour and the ciliary processes, it is plaited, and descends into the interstices of these processes.

When we take off the sclerotic and choroid coats of the eye, by dissecting them round the insertion of the optic nerve, and fold them back, carefully preserving the retina; and when we have taken away the ciliary processes from their adhesion, to the fore part of the retina, we find the retina to form a sac surrounding the vitreous humour, and supporting the lens. In all this surface, the membrane is smooth and uninterrupted.—To the margin of the lens all this sac is opaque; because, upon the outside of the retina, is the opaque pulpy nervous matter, but the coats of the lens are transparent, yet continuous with the arachnoid portion of the retina. When these parts of the eye are thus dissected, they hang all together by the optic nerve; viz. the lens, the vitreous humour, and the expanded matter of the nerve being supported by delicate and pellucid membranes, constituting part of the retina; and the organ is divested only of its outer apparatus; we still retain within this the more essential and important parts.

There is here a natural division; and I am willing to pause upon this, knowing well with how much difficulty the student gains a knowledge of the minute structure of the eye, when point follows upon point of the detail, without any resting-place or mark of division and character. All within the connexions of the retina, I shall call the INTERNAL GLOBE of the eye, as distinguishing it from the outward coats of the eye and parts subservient to them. A view of the little vascular system of these internal parts, thus classed, will show how strictly they are connected together, and how much insulated from the other parts.

But this is a subject upon which we cannot venture, until we have considered the nature and relative situation of the humours of the eye.

DIGRESSION ON THE SEAT OF VISION.

M. L'Abbe Marriotte discovered the curious fact, that when the rays fall upon the centre of the optic nerve, they give no sensation. He describes his experiment in this manner:— "Having often observed, in dissections of men as well as of brutes, that the optic nerve does never answer just to the middle of the bottom of the eye; that is, to the place where the picture of the object we look directly upon is made; and that, in man, it is somewhat higher, and on the side towards the nose; to make, therefore, the rays of an object to fall upon the optic nerve of my eye, and to find the consequence thereof I made this experiment. I fastened on an obscure wall, about the height of my eye, a small round paper, to serve me for a fixed point of vision; I fastened such another on the side thereof towards my right hand, at the distance of about two feet, but somewhat lower than the first, to the end that I might strike the optic nerve of my right eye while I kept my left shut. Then I placed myself over against the first paper and drew back by little and little, keeping my right eye fixed and very steady upon the same, and being about ten feet distant, the second paper totally disappeared."†

This defect in the vision of the one eye is corrected by that of the other; for the insertion of the optic nerves being towards the side next the nose, no part of an image can ever fall on the optic nerve of both eyes at once. The effect of vision, therefore, is observed only in very careful experiments. Experiments were, however, made by M. Picard, Marriotte, and Le Cat, to render this effect produced by the image falling on the centre of the optic nerve evident, when looking with both eyes. Marriotte's second experiment was this: place two round pieces of paper at the right of your eyes, three feet from one another, then place yourself opposite to them at the distance of 12 or 13 feet, and hold your thumb before your eyes at the distance of about eight inches, so that it may conceal from the right eye the paper that is to the left hand, and from the left eye the paper to the right hand. If, now, you look at your thumb steadily with both eyes, you will lose sight of both the papers.† The novelty of such a discovery was likely, as

* Vid. Phil. Trans. No. 35. Smith's Optics, Remarks on art. 87.

† Dr. Smith made the ſtream of light through the key-hole of a dark chamber fall upon this point of the retina, oppoſite to the termination of the optic nerve, but he found it quite inſenſible even to this degree of light. M. Picquet aſſerts, that very luminous objects make a faint impreſſion on the centre of the optic nerve. But Dr. Prieſtley ſays, that a candle makes no impreſſion on that part of his eye.

frequently is the case, to carry men's minds beyond the true point. It requires time for such facts to descend to their level, in the scale of importance, with other less novel observations. Marriotte, upon this fact, formed a new hypothesis relating to the seat of vision. We have observed, that the choroid coat and pigmentum nigrum are deficient, where the optic nerve enters the eye, and is about to expand into the retina. He fixed upon the most unaccountable supposition, that the retina does not receive the impression of the rays, but that the choroid coat is the seat of the sense. In support of this theory, he soon found other arguments than those arising from the deficiency of the choroid coat at the entrance of the nerve. He saw that the pupil dilated in the shade, and contracted in a more intense light: now, says he, as the iris is a continuation of the choroid coat, this is a proof of the great sensibility of that coat: again, the dark colour of the choroid coat he supposed to be well calculated for the action of the rays of light, which are not reflected from it or transmitted, but absorbed; while, on the other hand, the retina is transparent. If vision were performed in the retina, says Marriotte, it seems that it should be found wherever the retina is; and since the retina covers the whole nerve as well as the rest of the bottom of the eye, there appears no reason why there should be no vision in the place of the optic nerve. M. Picquet argued in opposition to Marriotte. He observed, in regard to the fitness of the black colour of the choroides for the action of the rays of light, that the choroid is not universally black; that there are many shades of difference in the human eye; and that it is black, blue, green, yellow, or of a metallic shining surface, in a variety of animals. He conceived, that the defect of vision at the insertion of the nerve is occasioned by the blood-vessels of the retina.* He observed, also, that the opacity of the retina is such, as necessarily to obstruct the transmission of the rays of light to the choroid coat. M. de la Hire took part in this controversy. He considered the retina as the organ of sight, although a particular point of it is not susceptible of immediate impressions from outward objects; for, says he, we must not conceive sensation to be conveyed by any other means than by the nerves. But, observing the constitution of the other organ of the senses, he entertained an idea that the retina receives the impression in a secondary way, and through the choroides, as an intermediate organ; that, by the light striking the cho-

* Againſt this hypotheſis, the ſize of the inſenſible ſpot was urged by Marriotte. Bernuoilli calculated that this ſpot is a circle, the diameter of which is a ſeventh part of the diameter of the eye, and that the centre is 27 parts of its diameter, from the point oppoſite to the pupil and a little above the middle.

roid coat, it is agitated, and communicates the motion to the retina; and we find that, through all the organs of the senses, he continues, the nerves are too delicate to be immediately exposed to the naked impressions of external bodies.

Another objection to the opinion, that the retina is the seat of sensation, has been lately urged, viz. that the thickness of this coat, together with its transparency, allows of no particular surface for receiving the image; and that its transparency would cause a partial dispersion, which would produce a confusion in vision.*

If these opinions require serious refutation, we have it in the effects of the diseases of the retina, optic nerve, and brain. But the thalami nervorum, the optic nerve, and its expansion into the retina, seem scarcely to have ever occurred to these speculators, as worthy of notice in this investigation.

The following appears to me the true account of this matter. It is demonstrated, that the inner surface of the retina is a web of membrane conveying vessels, and that the outer surface of the retina consists of the pulpy-like nervous matter. This latter, then, is the organized surface adapted to receive the impression of the rays of light. At the point where the optic nerve comes through the coats of the eye, there is no posterior surface peculiarly adapted to receive the impression of light; and, as well might we expect the optic nerve to be sensible to the impression of light in any point of its extent from the brain to the eye, as at this; for here the inner surface of the retina only is formed; there is no posterior surface upon which the rays can impinge. The doubts regarding the cause of this spot giving no sensation, have arisen from the idea, that the internal surface of the retina, or its substance, felt the impression of the rays of light.

At the same time, it is evident, that the choroid coat, and its secretion, is in a most remarkable manner subservient to the retina, as the instrument of vision: for, when the secretion is black, it absorbs the rays; and animals which have such a pigmentum nigrum, see best during the full day: again, when the surface is of a shining nature, it repels the rays, and this contributes to strengthen the sensation; and such animals are fitted for seeing in obscure light: nay, further, if the surface of the choroid be coloured, the animal will see objects of that colour the best, because the colour of the choroid depends upon its

* M. Le Cat thought that the pia mater was the ſentient part of the nerve. It was, therefore, a kind of confirmation of his opinion to ſuppoſe the choroid to be the ſeat of viſion, as he teaches that the choroid coat is a production of the pia mater. He conceived that the retina moderated the impreſſion of light upon the choroid coat, as the cuticle dulls the impreſſion on the papillæ of the tongue.

reflecting more of the coloured ray, than of the others of which light is composed.

But as animals see which have no paint on the choroid, neither such as will absorb, nor such as will strongly reflect the rays, and which have merely the surface of the choroid with its coloured blood-vessels in contact with the retina; so, it is evident, that it is not the deficiency of the choroid coat, nor the want of the black paint at the entrance of the optic nerve, which prevents the sensation, but really, that there is here no surface formed and organized to receive the impression of the light; the outer surface not being the sensible surface of the retina.

FURTHER OBSERVATIONS ON THE RETINA.

It has already been observed, that vision is the combined operation of the organ, nerve, and brain; consequently, the destruction of the function may be produced by disease of the retina, of the optic nerve, or of the brain. Disease in the retina, nerve, or corresponding part of the brain, causing total blindness, while the cornea and humours of the eye remain pellucid, is called AMAUROSIS. It is, in general, to be considered as a paralytic affection. Amaurosis* has been found to follow strokes on the head; concussion and compression of the brain; blood effused within the skull; or tumours pressing on the nerve or brain†. An amaurosis spasmodica has been enumerated by authors. This kind of blindness has been supposed to arise in consequence of the stricture of the optic nerve by the origins of the recti muscles; as far as I have observed, no action of these muscles can affect the optic nerve before it perforates the coats of the eye. If it were to be attributed to the operation of these muscles, I should rather suppose it to

* AMAUROSIS; GUTTA SERENA; CATARACTA NIGRA; which laſt name is from the blackneſs of the pupil in conſequence of the tranſparency of the lens.

† "Ipſe vidi bis in puerulis ſcrophuloſis amauroſin, etiam ſubito ingruentem; ſecto cadavere inveni glandulam ſtrumoſam nervis opticis incumbentem." *Sauvages Noſol.* From many obſervations, we find that tumours and extravaſations, which muſt compreſs gradually, do yet produce an inſtantaneous effect.

In Bonetus*, we have many caſes of blindneſs from abſceſs in the anterior part of the brain; from fluid on the ſurface, and in the ventricles; from ſteatomatous tumours; from coagulum of blood, and from a hydatid preſſing on the union of the optic nerves; and, laſtly, from a calculus in the optic nerve. Blindneſs from preſſure upon the eye and its diſplacement, and conſequent elongation of the optic nerve, by an encyſted tumour in the orbit, with gradual recovery after operations. See Med. Ob. and Inquir. vol. iv. p. 371.

* De Ocul. Affectibus, Ob. 2.

be occasioned by their spasmodic action on the ball of the eye, by which the function of the retina might be disordered; but I think it is more probable that the same irritation which is acting on the motatory nerves of the eye, does, in this instance, affect also the optic nerve and retina. However, distention of the coats of the eye, by increased secretion of the humours, destroys the sensibility of the retina. In the hydropthalmia, there is in the beginning a short-sightedness, so that objects are seen only when near the eye. Thus far we might account for the defect of vision by the alteration of the focus of the cornea and humours; but, bye and bye, as the eye enlarges, as it becomes turgid, and the coats more distended, the pupil becomes stationary, and the vision is lost before the aqueous humour has become turbid*.

The connexion and sympathy betwixt the retina and the viscera of the abdomen is sometimes very particular: I have seen frequently a proof of this in the disorder of the stomach having an immediate effect on the sensibility of the retina. Allied to this, but greater in degree, is the amaurosis which attacks hysterical women suddenly with head-ach and violent pain. From such sympathy of parts arise the amaurosis bilosa, verminosa intermittens, arthritica, &c. Such attacks of blindness have been found to alternate with convulsions†.

The amaurosis is a total blindness, while there is a transparency of the humours and coats of the eye. AMBLYOPIA is, on the contrary, only a partial privation of sight, with a pellucid state of the eye.

Commencing cataracts and opacities of the cornea, and of the humours in general, give occasion to spots and obscurities in the vision‡; but we have at present to consider those only

* To complete ſuch a caſe, we may further obſerve, that there is now an acceſſion of pain, a tenſion over the forehead and pericrania, and there is ſometimes accompanying it a ſwelling and inſenſibility of the ſide of the face. So luxation or diſplacement of the eye, by tumours, cauſes blindneſs, by extending the optic nerve or compreſſing the eye-ball and conſequently the retina.

† The following is an ingenious account of the manner in which this may be produced, though to me it is not ſatisfactory:—" Non infrequens cæcitas poſt convulſiones graves et frequentes, ſed a nemine quod ſciam recte deſcripta cauſa; hanc non ab humoris affluxu deduco, ut voluerunt, ſed quia in magnis illis per paroxyſmas convulſionum partium omnium, et oculorum ſimul contorſionibus in quibus ſæpe quoque convulſi, admodumque exerti et inflexi apparent, attracto ſic nimium et tenſo nervo optico, illis adnato illoque ſimul contorto et læſo, ſpirituſque viſorii tranſitu impedito, oculos viſione privari contingit, atque inde provenire diligente examine & conſideratione invenimus." Platerus Prax. lib. i. c. 7.

‡ CALIGO is an obſcurity in the viſion, depending on obſtruction to the rays, from opacities before the pupil. " CATARACTA opacitas eſt ultra pupillam."—AMBLYOPIA and AMAUROSIS are occaſioned by the diſeaſe of the nerve, or confuſion from the focal powers of the humours without opacity of any part. But Cullen extends the genus CALIGO to all obſcurities cauſed by opacity: he introdu-

which depend on the state of the nerve*. Errors of vision are not easily to be distinguished from those of the imagination proceeding from the brain. Error opticus, or Hallucinacio, from delirium : one distinction of the former is, that we can correct the deception by the assistance of the other senses, while, in the latter, the mind is diseased.

Old people are often troubled with the appearance of dark irregular spots flying before their eyes. In fever, also, it is very common to see the patient picking the bed-clothes, or catching at the empty air. This proceeds from an appearance of motes or flies passing before the eyes, and is occasioned by an affection of the retina, producing in it a sensation similar to that produced by the impression of images ; and what is deficient in the sensation, the imagination supplies ; for, although the resemblance betwixt those diseased affections of the retina and the idea conveyed to the brain may be very remote, yet, by that slight resemblance, the idea, usually associated with the sensation, will be excited in the mind.

M. de la Hire attributed the fixed spots to drops of extravasated blood on the retina, and the flying ones, to motes in the aqueous humours† ; but we shall show presently, that this apparent motion of the motes before the eyes may be a deception. After turning round upon the heel for some time, objects apparently continue in motion. Dr. Porterfield supposed this to proceed from a mistake with respect to the eye, which, though it be at rest, we conceive to move the contrary way to that in which it moved before ; from which mistake, with respect to the motion of the eye, the objects at rest will appear to move the same way the objects are imagined to move, and, consequently, will seem to continue their motion for some time after the eye is at rest. How superior is simple experiment to the most ingenious speculation ! Dr. Porterfield is presuming in all this, that the eye is at rest when the body is stationary, after turning round rapidly on one foot.—

ces the words " ob repagulum opacum, inter objecta & retinam," while Sauvage has the expreſſion " repagulum opacum citra pupillam."

* PSEUDOBLOPSIS is thus defined by Dr. Cullen : " Viſus depravatus ita ut quæ non exiſtant homo ſe videre imaginatur vel quæ exiſtunt aliter videt ac revera ſe habeant"—under this genus is SUFFUSIO, PHANTASMA. Under this definition all deceptions from refraction of the rays are naturally comprehended, as well as from the imagination ſimply : a definition comprehending defects of viſion which proceed from cauſes ſo very diſtinct, is an obſtruction to the knowledge of diſeaſes. Sauvage has it claſſed with the veſaniæ, viz. G. ſuffuſio, hallucinatio viſus circa objecta.

† " Guttula cruoris retinæ inſidens et nigricans, omnem lucem intercipiet unde phantaſma obſcurum vel nigrum ; verum ſi dilutus cruor radios rubros tranſmittat tunc maculam rubram videbit æger ut omnia trans vitrum inſpecta rubra ſunt." Sauvage, vol. iv. p. 287.

But the fact is, that the eyes continue in motion after the body is at rest, but owing to a disorder in the system of sensation we are not sensible of it. Dr. Wells, in making an experiment, in which it was necessary to look upon a luminous body, was seized with giddiness, and he found, that the spot on the retina, affected by the great excitement of the luminous body, did not remain stationary, but, when made apparent by looking upon the wall or any plane, was moved in a manner altogether different from what he conceived to be the direction of his eyes. In making the experiment after looking some time at a candle, and then turning himself round till he became giddy, he afterwards directed his eyes to the middle of a sheet of paper, he saw the dark spot (caused by the former brilliancy of the candle on the retina) take a course over the paper, although he conceived that the position of his eyes remained stationary.—He then directed a person to repeat this experiment, and then bade him look steadfastly to him, and keep his eyes fixed; but instead of keeping stationary, his eyes were seen to move in their socket; though, of this, the person himself was quite insensible.

From these experiments, we may conclude, that spots which seem to move before the eyes are not, on that account, solely to be attributed to opacity of the humours or cornea, since the appearance of motion may be given to those motes, though occasioned by an affection of the nerve; especially, if the unusual sensation be attended with giddiness. Giddiness, however, is not necessary to such sensation; when my eyes are fatigued, and, sitting in my room, I look towards the window, I see before me small lucid circles which seem to descend in quick succession; upon attending more particularly to my eyes, I find them in perpetual motion; my eye is turned gradually downward, which gives to the spectrum the appearance of descending: but it regains its former elevation with a quick and imperceptible motion. During the slow inclination of the eye downward, the motes or little rings seem to descend; but in lifting the eye again, the motion is so quick, that they are not perceived.*

* The following quotation refers to this fenfation :—" Aeger in magna luce conftitutus, ut plurimum prefbyta, vel oculis nitidiffimis gaudens, continuo præ oculis obfervari fibi putat puncta lucida, quæ non huc et illuc volitant, nec a commoto capite agitantur, ut putat la Hire, et ejus in hoc exfcripto Boerhaave; fed conftanter fi oculus immobilis remaneat, deorfum lentiffime delabi videntur; adeoque veluti pluvia aurea præ oculis eaque denfa cernitur; quæ verticaliter femper defcendit in quacumque capitis pofitura, five erecta, five lateraliter inclinata; hoc in me ipfo expertus per annos, obfervavi in aliis, potiffimum illis qui ftudio nocturno indulferant, et in aegrotante, qui de eo fymptomate ad melancholiam fere per multos annos follicitus erat." Sauvages. This appearance has been at-

There is a kind of umbræ seen before the eyes which are occasioned by the vessels of the retina. Of this kind is the suffusio reticularis of Sauvages, in which the person sees umbrageous ramifications which strike across the sphere of vision, and are synchronous with the pulse, showing its dependence on the full and throbbing pulsation of the head. There are also corruscations seen before the eyes in consequence of a blow upon the eye ball, and accompanying violent head-ach, vertigo, phrenitis, epilepsy, &c. Whatever forces the blood with great violence to the head, as coughing, vomiting, sneezing, will cause, for the instant, such corruscations, by means of the disturbed circulation through the retina.

We are particularly called upon to attend to the connection betwixt the iris and the retina. In amaurosis, the sensibility of the retina being entirely lost, the pupil is consequently immoveable and dilated.* But we must recollect, that if one eye be found, the pupil of the diseased eye follows, in some degree, the movement of the iris of the sound eye. If one eye be shut, the pupil of the other eye will dilate; if the hand be put over the eye-lids of the shut eye, the pupil will still further dilate.†

We find several instances of vision indistinct during full daylight, and perfect in the crepusculum. This we have explained by the dilatation of the pupil allowing the rays of light to pass the partial opacity of the lens; it, of course, has no connection with the disease of the retina.

There are also instances of vision being more than naturally obscure in the twilight, which is owing to a degree of insensibility.‡ The night blindness, however, is not to be entirely at-

tempted to be explained upon the fuppofition of a very fenfible ftate of the retina, which perceives the gutulæ exuding from the pores of the cornea, and which, falling over its furfaee, gives the appearance of their defcending. But it is only felt when the retina is exhaufted or difturbed by preffure on the eye-ball. See Sauvages Suffufio Scintillans & Suff. Danaës.

* There are, however, cafes of AMAUROSIS A MYOSI, in which there is a contracted and immoveable pupil, and children are born with an infenfibility of the organ in which the pupil is not greatly dilated. I would be willing to attribute this peculiarity of the pupil and apparent amaurofis in newly-born children to the remains of the membrana pupillaris.

† The fympathy of the iris with the retina I do not eonceive to be immediate, but through the intervention of the brain; and the degree of dilatation of the pupil, I fhould hold to depend on the ftrength of the common fenfation of both eyes. By this only ean we aeeount for the fenfibility of the retina of one eye affecting the iris of the other, or the difturbance of the brain, in comatofe difeafes, deftroying the fympathetie connexion betwixt the retina and pupil.

‡ Eft immanis differentia inter fplendorem et activitatem luminis candelæ et lunæ: luminis folaris vis eft ad vim luminis candelæ 16 pedes diftantis, obfervante D. Bonguer ut 11664 ad 1; et ad lumen lunæ in pleni lunio, ut 374000 ad 1 de-

tributed to a degree of continued insensibility in the nerve.—The attacks are irregular, and allied to the intermitting amaurosis. It has been epidemic, and the following cases seem to ally it with the paralytic affections.

CASE I. OF NYCTALOPIA, OR NIGHT-BLINDNESS, BY DR. HEBERDEN.

A man, about 30 years old, had, in the spring, a tertian fever, for which he took too small a quantity of bark, so that the returns of it were weakened without being entirely removed; he therefore went into the cold bath, and after bathing twice, he felt no more of his fever. Three days after his last fit, being then employed on board of a ship, in the river, he observed, at sun-setting, that all objects began to look blue, which blueness gradually thickened into a cloud, and not long after he became so blind as hardly to perceive the light of a candle. The next morning, about sun-rise, his sight was restored as perfectly as ever. When the next night came on, he lost his sight again in the same manner; and this continued for 12 days and nights. He then came ashore, where the disorder of his eyes gradually abated, and in three days was entirely gone. A month after, he went on board of another ship, and after three days stay in it the night-blindness returned as before, and lasted all the time of his remaining in the ship, which was nine nights. He then left the ship, and his blindness did not return while he was upon land. Some little time afterwards, he went into another ship, in which he continued ten days, during which time the blindness returned only two nights, and never afterwards.

In the August following, he complained of loss of appetite, weakness, shortness of breath, and a cough; he fell away very fast, had frequent shiverings, pains in his loins, dysury, and vomitings; all which complaints increased upon him till the middle of November, when he died. He had formerly been employed in lead-works, and had twice lost the use of his hands, as is usual among the workers in this metal. Medical transactions, published by the College of Physicians in London, vol. i. p. 60.

monſtrante D. Euler Mem. de l'Acad. de Berlin, an 1750, pag. 299. non mirum itaque ſi vis toties major ſufficeret ad ſuccutiendam retinam quam tanto minor non afficiebat. *Sauvages Amblyopia Crepuſcularis.*

CASE II. OF NYCTALOPIA, BY DR. SAMUEL PYE.

Pye, servant to a miller, at the 6th mill, on the Lime-house wall, about 40 years of age, came to me October 2d, 1754, for advice and assistance. He told me, that about two months ago, while he was employed in mending some sacks, near the setting of the sun, he was suddenly deprived of *the use of his limbs* and of his sight. At the time he was attacked with this extraordinary disease, he was not only free from any pain in his head or his limbs, but, on the contrary, had a sensation of ease and pleasure ; he was, as he expressed himself, as if in a pleasing dose ; but perfectly sensible. He was immediately carried to bed, and watched till midnight ; at which time he desired those who attended him, to leave him, because he was neither sick nor in pain. He continued the whole night totally blind and without a wink of sleep.

When the day-light of the next morning appeared, his sight returned to him gradually as the light of the sun increased, till it became as perfect as ever ; when he rose from bed, his limbs were restored to their usual strength and usefulness, and himself in perfect health.

But on the evening of the same day, about the setting of the sun, he began to see but obscurely, and his sight gradually departed from him, and he became as blind as on the preceding night ; though his limbs continued as well as in perfect health ; nor had he, from the first night, any complaint from that quarter.

The next day, with the rising sun, his sight returned ; and this has been the almost constant course of his disease for two months past. From the second night, the symptoms preceding the darkness were a slight pain over the eyes, and a noise in his head, which he compared to a squashing of water in his ears.

After near two months continuance of the disease, on September the 29th, the patient was able to see all night ; on the 30th September, October 1 and 2, he was again blind all night ; on the 3d, he was able to see : on the 4th, he was blind till 12 ; on the 5th was blind. From this he had no return of his complaint till June 1755 ; from which time till the 3d of October, when I again saw him, he had three or four attacks ; from the 3d till the 10th, he had an attack every evening.—He had at this time a purging. I ordered him an electuary of bark and nutmeg, which succeeded in removing the blindness, but the diarrhœa continued wasting him. On the 20th, deliri-

um came on; on the 21st, he became deaf; he died on the 25th, after having suffered from fever, pain in his bowels, and continued diarrhæa; but the defect in his eyes never returned after the 10th. This man had clear bright eyes: when his sight failed him the pupils were enlarged about one-third in diameter. Medical Facts and Inquiries, vol. i. p. 111.

Boerhaave gives us an example of imperfect vision, from a discordance betwixt the contraction of the iris and the excitement of the retina; so that the pupil did not dilate in proportion to the decay of light.*

When inflammation extends within the eye, or when the retina is excited by sympathy with the ophthalmia of the outer membranes, it may happen that the patient is totally blind during the day, and yet sees on the approach of evening; because, from the sensibility of the retina, the pupil is absolutely shut, but as the light is diminished the pupil is gradually relaxed, and the obscure light admitted, and this obscure light, from the irritable state of the retina, gives a vivid sensation incomprehensible to the by-standers. Our judgments of the strength of sensations are comparative merely; when we have been accustomed to strong impressions, lesser ones are disregarded. The greater light destroys the capacity of the retina for receiving slighter and more delicate impressions; while, on the other hand, the absence of light reserves to us the power of seeing objects the most faintly illuminated. We are every day becoming more acquainted with the invisible properties of light; and we have frequent experience of darkness being relative, and that what we should call total darkness is very often but a fainter light. One man will see distinctly, when another is quite deprived of the power of discerning objects. A man in prison seems to have the light gradually admitted to him; and many animals are in quick pursuit of their prey, while we are groping our way with the assistance of our other senses.

Animals which seek their prey in a light which is darkness to us, have, most probably, a greater degree of sensibility of the retina. But they have also a more conspicuous apparatus in the largeness of their eyes, and the dilatability of their pupil, while the sensibility which this provision gives, is often guarded from the light of day by the membrana nictitans, and by an iris capable of great contraction. Their iris possesses also a great power of contraction in narrowing the pupil during the day, as it is capable of dilating during the night, to the

* In old people there is an obſcurity of viſion, from a diminiſhed ſenſibility of the retina; and the iris does not take a quick ſucceſſion of contraction and dilatation with the change of light.

whole extent of the cornea. In the human eye, also, the strict sympathy between the iris and retina is a guard to the latter. But it has often happened that, in using optical instruments, the retina has been hurt by the intensity of the light from the concentrated rays : a lesser degree of this effect we have given us in the following instance.*

"Being occupied in making an exact meridian, in order to observe the transit of Venus, I rashly directed to the sun, by my right eye, the cross hairs of a small telescope. I had often done the like in my younger days with impunity ; but I suffered by it at last, which I mention as a warning to others. I soon observed a remarkable dimness in that eye, and for many weeks, when I was in the dark, or shut my eyes, there appeared before the right eye a lucid spot, which trembled much like the image of the sun seen by reflection from water. This appearance grew fainter, and less frequent by degrees, so that now there are seldom any remains of it. But some other very sensible effects of this hurt still remain :—For, first, the sight of the right eye continues to be more dim than that of the left ; secondly, the nearest limit of distinct vision is more remote in the right eye than in the other, although, before the time mentioned, they were equal in both these respects, as I had found by many trials ; but, thirdly, what I chiefly intend to mention is, that a straight line, in some circumstances, appears to the right eye to have a curvature in it. Thus, when I look upon a musick book, and, shutting my left eye, direct the right to a point of the middle line of the five which compose the staff of musick, the middle line appears dim indeed at the point to which the eye is directed, but straight ; at the same time the two lines above it and the two below it appear to be bent outwards, and to be more distinct from each other, and from the middle line than at other parts of the staff to which the eye is not directed. Fourthly, although I have repeated this experiment times innumerable within these 16 months, I do not find that custom and experience takes away this appearance of curvature in straight lines. Lastly, this appearance of curvature is perceptible when I look with the right eye only, but not when I look with both eyes ; yet I see better with both eyes together than even with the left eye alone."

Herschel, in making his observations on the sun, found the irritation proceeding from the red rays (being those of the rays of light which have the property of producing heat in the greatest degree ;) he found, when he used red glass to intercept the too vivid impression of light on his eyes, that they stopped the

* Viz. by Dr. Reid.

light, but produced an insufferable irritation from the degree of heat. But when he used green glass, it transmitted more light, and remedied the former inconvenience of an irritation arising from heat. He concluded, that in the darkening glasses for telescopes, the red light of the sun should be entirely intercepted. Boerhaave mentions an instance of the retina being injured by the long use of the telescope, and he himself was hurt by a similar cause. These injuries are owing to the intrusion of light highly concentrated, and over which the pupil has no command; it is a degree of intensity which the organ is not prepared to counteract.

CHAP. VI.

OF THE MEMBRANA PUPILLARIS.

THE membrana pupillaris is an extremely vascular membrane, which is extended across the pupil of the fœtus. It was discovered by Haller, Albinus, Wachendorf*, and Dr. William Hunter, at the same time or without correspondence with each other. Haller†, after injecting, with oil of turpentine and cinnabar, a fœtus of the seventh month, saw through the cornea the vessels of the iris injected, and some ramifications from them produced into the space of the pupil. From conviction that no vessels ramified without an involving membrane, he naturally concluded, that a membrane was drawn across the pupil of the fœtus, though, in this instance, it was about to disappear.

In several other fœtuses of the seventh month he confirmed his first observation; and, cutting off the cornea, he observed the membrane impelled forward by the humours behind like a little vesicle.

Albinus, in his first book of Academical Annotations, thus describes the way in which he detected this membrane. In the same child in whom he had filled the vessels of the crystal-

* In Commercio Norico, A. 1740, hebd. 18. as quoted by Haller.
† De nova tunica pupillam fœtus claudente. Oper. minor.

line, he also first observed the membrane which closes the pupil, and in which the vessels were injected that came from the margin of the pupil. Upon looking through the cornea, he could see no distinction of parts, but all seemed vascularity. He conceived, at first, that these were the vessels of the uvea, and that it had quite contracted and had shut the pupil; then that they were the vessels of the capsule of the crystalline lens; but having cut into the eye, he found it to be this membrane. Dr. Hunter, speaking of this membrane, and of Albinus's claim to the discovery, says, "In justice to this great anatomist, I must declare that I believe this, both because he asserts it and because I know from the circumstances it was hardly possible he could miss taking notice of it in that child." "I have always observed (he continues), both in the human body and in the quadruped, that there is a great resemblance to one another in the vessels of the capsula cristallini and of the membrana pupillæ. In an injected fœtus, I always find both nearly in the same state: if one be filled only with the blood that is drove before the injection, so is the other; if one be filled partly with injection, and partly with blood, the other is in the same condition; if one, by good fortune, be finely and minutely filled by injection, the other is so too; if one be burst by extravasations, the other is commonly in the same state; and when the fœtus is so near its full time that the one cannot be injected, neither can the other*."

Dr. Hunter, speaking further of the artery of the crystalline capsule, says, "that it does not terminate at the great circle of that humour. Its small branches pass that circle, and run a very little way on the anterior surface of the crystalline humour before the points of the ciliary processes; then they leave the humour and run forwards, supported on a very delicate membrane, to lose themselves in the membrana pupillæ." He continues: "The membrana pupillæ receives two different sets of arteries, one larger, from the iris, and the other much smaller, but very numerous from the crystalline capsula."

Now I think that every expression in these excerpts confirms the opinion I entertain, that these vessels which are seen filled with red blood, and which take their course through the humours, are subservient merely to the membrana pupillaris.

The first time I observed the membrana pupillaris was in the eye of a child born at the full time. I had injected the child very minutely with size and vermilion, and the iris was beautifully red and the pupil quite transparent and black, and not obscured by any extravasation of the injection into the aqueous

* See Medical Commentaries, p. 63, foot note.

humour: upon very narrowly observing the circle of the iris, I saw distinctly a small injected vessel pass out from the edge of the iris, and crossing the pupil, divide into two branches which ran into the opposite margin of the iris. This was the remains of the membrane, but so delicate and so perfectly transparent, that the presence of it was only to be argued from the vessel which was seen to cross the pupil.

Since that time I have often seen it in the early months, and particularly strong about the seventh month of the fœtus. It is then an opaque, and very vascular membrane, and generally it has spots and streaks of extravasation in it. The vascular structure of this membrane is very particular, and I can assign no other reason for this than that it may be a provision for its rapid absorption. It has evidently two sources of vessels, viz. the vessels of the capsules and those of the iris; but whether the arteries come by the one source, and the veins depart by the other, I cannot as yet determine. In one preparation I see the vessels with their trunk in the membrana pupillaris, and the branches sent over the surface of the iris.

The larger and flat venous-like vessels of the membrane are distributed in a beautiful net-work, in the form of the lozenge of a Gothic window. They have a free communication with each other. In their whole course the vessels seem nearly of the same size, (which also is like the character of a venous net-work), and they terminate apparently in the margin of the iris.

The use of the membrana pupillaris I think sufficiently apparent, though I do not find that it has hitherto been understood. Haller makes a comparison betwixt this membrane, which closes up the pupil, and that matter which is accumulated in the passage of the ear in the fœtus. But there is no analogy. As the waters of the amnios might otherwise be in contact with the membrane of the drum of the ear, and injure what necessarily is of a dry and arid nature, to adapt it for receiving the vibrations of the air, this matter accumulated in the ear of the fœtus defends it. But at the time, when the membrana pupillaris exists in its full strength and vascularity, no light is admitted into the eye—the fœtus is lying in its mother's womb. Towards the ninth month, the membrane has become transparent, and if not totally absorbed, it is torn by the first motion of the pupil and altogether disappears. It can therefore have no effect in obscuring the light, and preventing it from exciting in too great a degree the eye of the newly-born child. To explain the effect of this membrane, then, we have only to consider that it is of the nature of the iris to contract its circular fibres during the operation of light, so as to

close or nearly close the pupil; that, on the other hand, the pupil is completely dilated through the operation of the radicated fibres of the iris in darkness:—To the question, then, why it is not dilated during the fœtal state? The answer, I think, is decidedly this:—The iris is not loose in the fœtal state, it is connected and stretched to the middle degree of contraction and dilatation by the membrana pupillaris. Were the iris in a full state of contraction, during the life of the fœtus, it could not receive its full nourishment, proper degree of extension, and due powers; but being preserved stationary and extended, the disposition to contraction, which it must have when the retina is without excitement, is counteracted, until it is about to receive, by the birth of the child, that degree of excitement which is to keep up the preponderance towards the contracted state of the pupil.

CHAP. VII.

OF THE HUMOURS OF THE EYE.

OF THE AQUEOUS HUMOUR.

THE aqueous humour is perfectly limpid. It has no capsule or surrounding membrane, as it is not in consistence allied to the other humours, but is fluid*. The use which I have assigned to the aqueous humour explains its nature and the extent of the chamber which contains it, viz. that it distends the cornea and allows the free motion of the iris; it consequently fills the space between the lens and cornea. The usual description is, that it is lodged in two chambers; the one before the iris, called the anterior chamber of the aqueous humour, and the other behind the iris, called the posterior chamber of the aqueous humour.

* It poſſeſſes, however, a degree of viſcidity. Winſlow.

This posterior chamber was, at one time, conceived to be of great extent*, and authors spoke of depressing the lens into the posterior chamber of the aqueous humour†. It is found, now, that betwixt the lens and iris there is no space to which we ought to give this name of chamber.

Heister, Morgagni, and M. Petit (medecin) first demonstrated the extreme smallness of the posterior chamber, and after them Winslow confirmed the fact, that the iris moved almost in contact with the anterior surface of the lens.

M. Petit gave the clearest proof of the smallness of the posterior chamber, by freezing all the humours of the eye, and dissecting them in their solid state. Without this expedient it was impossible to prove the relative size of the two chambers; for, whenever the cornea was cut, the aqueous fluid escaped, and the lens pushed forward. When the eye was frozen, and then dissected, it was found that the ice, which took the shape and dimensions of the anterior chamber, was much larger than that found in the posterior chamber‡; indeed the latter was formed of a very thin flake of ice. The thin piece of ice in the posterior chamber indicated as much fluid only betwixt the iris and lens as might allow a free motion to the iris. These experiments were instituted in the course of investigating the question of the nature of the cataract.

The conclusion, that the posterior chamber of the aqueous humour contained but one-fourth of the whole aqueous humour, was admitted with great difficulty and after much contest. It determined the question, whether the cataract was a membrane or the opaque lens; for, as those who maintained that it was a membrane, said it could not be the lens, because the lens was far distant from the iris, it was necessary for their opponents to prove that the lens was close upon the pupil, and that the posterior chamber of the aqueous humour was very small.

It is agreed that, in the adult, the quantity of the aqueous humour amounts to five grains; in the fœtus it is red, turbid, and weighs about a grain and a half, owing, in part, to the comparatively greater thickness of the cornea.

As it is natural to conceive that the aqueous humour flows from a vascular surface, it is the most generally received opinion, that it is derived from the points of the ciliary pro-

* Viz. by Heifter. They were called the firft and fecond chambers by M. Briffeau.

† There certainly appears fufficient room for this in Vefalius and Briggs' plates: thefe plates have mifled many.

‡ See Acad. Roy. des Sciences, 1723. Mem. p. 38.

cesses and surface of the iris. Haller, particularly, and after him Zinn, have thought that the ciliary processes were the secreting bodies; but there is one argument which, in my mind, determines that these are not the sole secreting parts, viz. that while the membrana pupillaris closes up the communication betwixt the two chambers, I have observed the anterior one to be full of the fluid, which of course must have been supplied from another source than the ciliary processes. I suppose, therefore, that the villous surface of the iris is the proper secreting surface of the aqueous humour*. Zinn observes, that Haller saw the membrana pupillaris distended and bulged forwards by the aqueous humour in the posterior chamber. It is scarcely necessary to say, that this must always take place when the cornea is first opened in demonstrating that membrane, whether there be a watery fluid behind it or not. But I believe I shall be able to prove, that the secretion of the ciliary processes can have little power of filling the posterior chamber, even from the connexion of membranes behind the membrana pupillaris in the fœtus. The aqueous fluid is perpetually undergoing the change of secretion and absorption, and this is the reason of its quick renewal when it has been allowed to escape by puncture of the cornea. The ancients were not ignorant of the quick regeneration of this fluid. It was proved to the moderns by a charlatan, Josephus Burrhus (ventosus homo, qui in carcere Romano periit). Before the physicians of Amsterdam he punctured the cornea of a dog; then instilling his liquor under the cornea, he bound up the eye; in a few days he took off the bandage, and showed them the cornea again distended with the aqueous humour. It was soon found that the instilled fluid was of no kind of consequence. Redi and Nuck made many experiments, and it was found that the aqueous humour was regenerated in the course of 24 hours.

When the disputes regarding the cataract ran high, and when, to make new distinctions in the disease was taken as a mark of practical knowledge and of acuteness, there was a kind of cataract attributed to the aqueous humour. When the aqueous humour became turbid, white, and opaque, and obscured the pupil, they were absurd enough to call this a

* The opinion of Nuck is now out of the queſtion. He thought that he had diſcovered particular aqueducts, which conveyed the aqueous humour into the anterior part of the eye; but theſe are found to be nothing more than the ſhort ciliary arteries which pierce the fore part of the ſclerotica. M. Merry and Bonhomme, (ſee Zinn, p. 143.) obſerved, in an adult, the pupil cloſed with a membrane, and, in this inſtance, there was ſcarcely any fluid in the anterior chamber, whilſt the poſterior was turgid with fluid.

cataract. The turbid state of the aqueous humour is at once distinguishable, from the opaque lens, because it obscures the iris as well as the pupil.

Pus is formed in the chambers of the aqueous humour, in consequence of deep inflammation, contusions, &c. and from the same cause, sometimes, proceeds a bloody effusion. When the pus has lodged in the anterior chamber of the aqueous humour, it would appear, upon the authority of Galen, that an oculist of his day performed a cure by shaking the patient's head !* It is an operation of oculists to puncture and allow the pus to flow out, and some have even syringed out the pus with water ;† but this must have been on the principles of Joseph Burrhus's exhibition ; for the natural secretion is here the best deluent. When we recollect the nature of the parts with which the pus lies in contact, we cannot be sanguine in the hope of such an operation saving the eye. Sometimes there remains, after operation on the cornea, or in consequence of ulceration, a continued flow of the aqueous humour ; the consequence is a subsiding of the cornea :‡ it becomes corrugated, opaque, and, from the contact of the iris, apt to adhere to the iris. In consequence of this suppuration, there sometimes follows an absolute obstruction of the pupil, from the coalescing and adhesion of the edges of the iris.§

THE VITREOUS HUMOUR.

The vitreous humour, as already explained, occupies almost entirely the great ball of the eye. It is consequently beyond the lens, and keeps it at the requisite distance, to cause the rays from objects to concentrate and impinge upon the retina. The vitreous humour is considerably denser than the aqueous humour ;‖ but its peculiar appearance, its glairy-like consistence, is not owing to its density, but to the manner in which it is contained in its membranes. From being contained in a cellular structure of perfectly pellucid membranes, it has the adhesion and consistence of the white of an egg. This mem-

* Mouchart ſays, he has often ſeen the oculiſt Woolhouſe repeat this cure by ſhaking his patient's head over the ſide of the bed. He attributed the cure to the falling of the pus into the poſterior chamber, which, he ſuppoſes, has parts more capable of abſorbing it.

† They were at variance regarding the place at which to puncture for this diſcharge :—Some did it behind the iris ; there we know there is a crowd of veſſels ; the beſt place is the lower edge of the cornea before the iris. It ſeems to have been no uncommon accident, in this operation, to find the lens protruded through the pupil. The reaſon of this has been already explained.

‡ Rhytidoſis, ſeu ſubſidentia & corrugatio corneæ.

§ Viz. Syniſeſis. There has occurred congenital imperforation of the pupil.

‖ It is, according to Dr. Monro, in the proportion of as 1016 to 1000.

branous structure of the vitreous humour has been demonstrated by acids and by freezing. When frozen, it was found to consist of pieces of ice connected by strong membranes, which separated with difficulty, and showed their torn fragments; and M. Demours lifted the transparent membranes with the point of a needle. Although the vitreous humour appears to to be gelatinous, it is not so in reality, and when it is taken from the coats of the eye, it retains the shape for a time, but gradually subsides by the fluid exuding from the membranes, and this is accelerated by puncturing it.

OF THE CRYSTALLINE LENS.

The crystalline humour is a small body, of the shape of an optician's lens, of great power. It is of perfect transparency, and of density much greater than the vitreous humour. Its density to that of the vitreous humour is calculated to be as 1114 to 1016. But the crystalline is not of uniform density, for the centre forms a denser nucleus.

The form of the crystalline is that of a compressed sphere, the anterior surface being more compressed or flatter, though, in a degree, convex. According to Petit, the anterior surface is the segment of a sphere whose diameter is 7, 8, or even nine lines. The posterior surface is a sphere of 4 3-4 or 5, or 5 1-2 lines in diameter. The internal structure of the lens is quite peculiar, and resembles neither the vitreous nor the aqueous humour. By maceration, it splits into lamellæ, and at the same time bursts up into equal parts, so that there is first a stellated-like fissure, and then it separates into pretty regular divisions; and after maceration in acids, the lens can be teased out into minute shreds and fibres.*

From its form, density, and central nucleus, it has great power of converging the rays of light; and in an eye properly constituted, it concentrates them accurately to the surface of the retina. For this reason, it is placed before the vitreous humour, and socketed in its anterior part. It is contained in a capsular membrane, which membrane is continued from, or connected with, the membranes of the vitreous humour: but this is a subject which requires a more particular investigation.

* See further of the mufcularity of the lens.

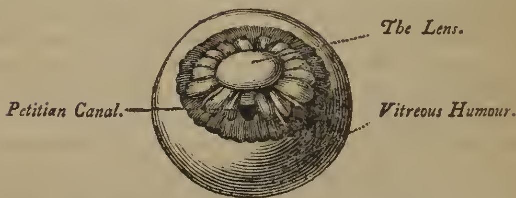
OF THE CAPSULE OF THE LENS AND VITREOUS HUMOUR.

Marg. Plate, 13.

Fig. 2.

Fig. 3.

Fig. 1.



In fig. 1. we have the appearance of the petitian canal blown up. It is not found full of any fluid, it is only the laminæ of membrane inflated, and it is best demonstrated by cutting off the cornea, and with it a small circular portion of the sclerotica, and taking with these the iris also, when the lens presents itself seated firmly in its capsule on the vitreous humour. Now laying back the ciliary processes, we make a fine puncture with a lancet by the side of the lens, and then blow gently into it with the blow-pipe.

Every anatomist acknowledges the existence of the petitian canal, and a distinct capsule to the lens is also pretty generally allowed. But many deny that the vitreous membrane has two plates, without observing that the existence of the petitian canal is a proof of the splitting of the membrana vitrea, on the fore part at least. Some believe that the vitreous membrane splits and involves the lens, and forms its capsule; but the difficulty, on this supposition, is still to account for the formation of the canal which surrounds the lens; for as the fluids on the surface of the lens and within its capsule have not admission to the canal, the canal must be distinct; and, indeed, sometimes we blow up the circular canal, and sometimes by

a wrong puncture, the capsule of the lens itself; but not both at once.

Seeing, then, that these cavities are distinct, some anatomists have admitted that the membrana vitrea is double; that the lens has its proper capsule; and that the lamina of the vitreous membrane, coming near the margin of the lens, splits and involves it in a second coat, (as in fig. 2.) Others have supposed that the anterior layer of the vitreous humour does not pass over the anterior surface of the proper capsule of the lens, but only adheres to the edge of the capsule of the lens, and forms the petitian canal. There are yet others who have described the membrana vasculosa of the retina as forming the capsule of the lens. This is one of those pieces of anatomy which provokes us to continued research, and mortifies us with continual disappointment. If this piece of anatomy, when investigated in the eye of an adult, is difficult to be understood, it is infinitely more complicated in the eye of the fœtus; and, for my own part, I cannot reconcile my experience with any former opinion.

I conceive that it is the membrana vasculosa tunicæ retinæ, or membrana vasculosa ruyschii, which forms the vascular capsule of the lens in the fœtus, and also the canal of Petit in the adult. The crystalline lens has, in the first place, its proper capsule, which surrounds it on all sides: again, the transparent web of membrane that is continued onward from that part of the retina which has upon it the pulpy and nervous expansion, splits when it approaches the margin of the lens.—One lamina goes round behind the lens, and the other passes a little before it, forms an adhesion to the capsule of the lens, and is then reflected off to the points of the ciliary processes and to the membrana pupillaris of the fœtus.* Betwixt these split laminæ of the continued membrane of the retina, the canal, which surrounds the lens, is formed. The membrana vitrea is simply reflected over the back of the lens, and has no part in forming the petitian canal. Where the retina advances forward upon the ciliary processes, it forms an adhesion, beyond which the medullary part is not continued; but the membrana vasculosa passing onward, as I have described, embraces the lens, and the lamina, which passes behind the lens and before

* In the fœtus, as far as I have obſerved, the proper capſule of the lens and the membrana pupillaris lie in contact, but they do not adhere; and while the membrana pupillaris is perfectly red with injection, there is none to be ſeen on the fore part of the capſule. There is, indeed, no part of that ſurface which is afterwards to ſecrete the aqueous humour, which could ſecrete that fluid, betwixt the ſurface of the lens and membrana pupillaris: ſo complete is the adheſion of the adventitious and vaſcular tunic of the lens to the membrana pupillaris.

the vitreous humour, receives and conveys the artery of the capsule; on the fore part of the lens the anterior lamina only touches the capsule of the lens, adheres and is then reflected off to form the membrana pupillaris.

In this account I am supported by the most careful investigation, and by the simplicity of this system of vessels: for it will be observed, that it is on the membrana vasculosa alone that the vessels, carrying red blood in the fœtus, are supported, and that it shows throughout the same character for vascularity. Again, I think it probable that this membrane which passes before the lens, viz. the membrana pupillaris, and that which passes behind the lens, forming the vascular capsule of the lens, disappears at the same time; or if this posterior and vascular membrane which passes behind the lens is not totally absorbed, it becomes thin and more intimately united to the membrana vitrea.

CHAP. VIII.

OF THE DISTRIBUTION OF THE CENTRAL ARTERY AND VEIN OF THE RETINA.

I AM the more anxious to give the accurate distribution of these vessels, that Walter's account of them has tended much to derange that simple and natural view of this system which observation authorizes us to take.

The arteria centralis retinæ arises from the ophthalmic artery.* Sometimes it is derived from the ciliary arteries before they enter the coats of the eye, and often there is more than one branch entering the optic nerve.† Arising from this source, there are many branches which are distributed to the retina, while a branch passes onward from the lamina cribrosa through the vitreous humour to the capsule of the lens. This vessel does not pass exactly in the centre of the vitreous hu-

* See Haller, Fascic. vii. tab. vi. fig. 2. 4. 7.

† Haller, F. vii. p. 42.

mour, but to one side of the axis of the eye. When it arrives near the capsule of the lens, it divides into three or four branches, which, reaching the capsule, spread beautifully on the back part of it.*

The BRANCHES of the arteria centralis retinæ, which are distributed in the retina, are subservient to its support, and are consequently as visible in the adult as in the fœtus ; and, where the membrane of the retina has been described as adhering to the point of the ciliary body, these vessels of the retina unite to, or inosculate with the vessels of the ciliary processes.

Walter objects to the description of the arteria centralis retinæ given by Haller and others ; he says, decidedly, that there are no arteries distributed to the retina, and that anatomists have deceived themselves in supposing those vessels which ramify on the retina, to be arteries, when, in reality, they are veins ; he conceives, that the free return of the injection from the extremities of the arteries into the veins has misled them.

I am at a loss to conceive what notions professor Walter can have entertained regarding this vein distributed in the retina, without an accompanying artery. It is a supposition contrary to the general frame of the œconomy, and I would oppose to it, with confidence, my own experience, since, in the ox and other animals, I have seen the veins of the retina turgid with blood and exceedingly distinct ; yet when I injected the trunk of the artery at the root of the optic nerve, I found a set of vessels injected on the surface of the retina quite distinct from the turgid veins, and which could be no other than the arteries distributed to the retina. I must conclude that there is no peculiarity in the distribution of vessels in the tunica vasculosa retinæ.

We frequently observe, that the trunks of veins and arteries, destined to the same final distribution, take a different course ; but in their final distribution, I know no instance in which they do not ramify with parallel branches interwoven with each other.

The VENA CENTRALIS RETINÆ, as it is described by Haller, is sometimes a branch of the ophthalmica cerebralis, but often it rises from the cavernous sinus, amongst the origins of the external and inferior recti muscles of the eye ; after giving off

* Walter (de venis oculi) ſays, the arteria centralis retinæ, having perforated the membrana hyoloidea, paſſes through the middle of the vitreous humour, and ſcatters ſome twigs on the ſmall cells of the vitreous humour. It does not, he ſays, run through the vitreous humour in a ſtraight line from behind, forward, nor does it divide into a great number of branches in the poſterior part of the capſule of the lens, like radii from a centre, as Zinn has deſcribed. He aſſerts that the lens receives its veſſels from the inveſture of the membrana hyoloidea, and that they run back from the edge of the lens towards the poſterior convexity.

many small twigs to the periosteum and fat of the orbit, it passes obliquely from behind, forward, and inward, perforates the sheath of the optic nerve, and, after supplying the sheath, dips into the surface of the nerve.—It is now the comes arteriæ centralis retinæ. It enters through the cribriform plate of the optic nerve, and spreading generally in large and remarkable branches on the retina, these make free inosculations with each other, and finally inosculate with the veins of the ciliary processes.

Whether a branch of the vena centralis retinæ is sent off to accompany the branch of the artery which takes its course through the vitreous humour, I have not been able to determine.

CHAP. IX.

OF THE VASCULARITY OF THE PELLUCID MEMBRANES.

IF we cut through the sclerotic and choroid coat, round the optic nerve as it enters the eye, and afterwards cut up the outer coats towards the cornea, the humours fall out from these coats, and will remain suspended in a fluid, hanging by the optic nerve and closely embraced by the retina : we have now to review these parts taken collectively, independent of the outward and proper coats, and, as I have classed them, as constituting the internal globe of the eye.

The first peculiarity which strikes us here is the perfect transparency of all the parts within the embrace of the retina. As there are, in the adult and healthy eye, no vessels to be seen in the transparent membrane and humours, it becomes a question, whether nature has provided for the support and nourishment of those parts by other means than the common circulation of red blood through vessels? Now, I am inclined to think, that there is no such circulation through them ; and I believe, that this would be much more generally allowed, were there not something like a proof remaining in men's minds that these humours and tunics were supplied with red blood in the fœtus; whence they deduce the natural conse-

quence that, in the adult state, these vessels are only shrunk so as to convey only colourless fluids. I have, therefore, in the first place, to give my reasons why I think that these vessels of the fœtus are not subservient to the humours; and, I think, I shall prove that, when they have once disappeared, they are no longer pervious vessels; that, though those parts which they are supposed to supply, should become inflamed and vascular in the adult, these vessels which were apparent in the fœtus do not become enlarged; that they do not administer in any way to inflammation and disease, but that a new source is given, and that vessels are formed which were at no former period discernible.

Why should there be red blood transmitted to the pellucid membranes and humours of the fœtus? Why is not that state of circulation, which nourishes and supports the parts in the adult state, sufficient for their growth and the progress to perfection which they undergo in the fœtus? Why is the capsule of the lens only crowded with vessels carrying red blood, while the proof of vessels passing to the cells of the vitreous coat stands upon some very rare and vague assertions, and such as can be naturally explained by the appearance of those vessels which merely pass through the vitreous humour for a different destination?

I believe this is a view which has been little attended to; but, upon the most minute inquiry, and upon examining the preparations of the vascularity of the eye of the fœtus, I can see no vessels, passing into the humours and carrying red blood, which are not finally distributed to the membrana pupillaris. When we lay open the eye of a fœtus, after a very minute and successful injection, we see vessels, which all proceed from the centre of the optic nerve, passing through the vitreous humour to the back of the capsule of the lens, viz. the branches of the arteria centralis retinæ. This artery divides very often into many branches before it arrives at the capsule of the lens: now, if these be filled with blood, or but partially injected, they have the appearance of being branches distributed to the vitreous humour, and not to the lens. This appearance is still more apt to deceive us when the lens is separated from the vitreous humour, and when the vitreous humour is otherwise disturbed, for then the vessels shrink and seem to terminate in the midst of the vitreous humour. When the injection is perfect there is no such appearance.

On the back of the lens we see a profusion of vessels; but I think I may positively say that these vessels do not penetrate to the lens itself, but are merely on the capsule, and that having made the circuit of the lens, they terminate in the mem-

brana pupillaris and ciliary body. I can observe no villi on the inner surface of the capsule of the lens, nor any appearance of its being a secreting surface, to lead me to suppose that these vessels secrete the lens, as Walter supposes they do ; nor, after the most successful injection of the capsule of the lens and of the coats of the eye in general, can I observe the slightest stain of colour in the pellucid state of the lens, nor betwixt its white fibres when it becomes opaque. Nor have I observed, at any time, a single branch of these vessels, which are so profuse on the back of the lens, distributed to the anterior part of the capsule ; on the contrary, they all terminate abruptly at that line, a little forward from the utmost verge of the lens, where they are united to the vessels of the membrana pupillaris and ciliary processes. Were these vessels of the capsule provided for the secretion of the lens, or were those vessels the trunks of lesser branches which pierce into the substance of the lens, they would appear also on the fore part of the capsule.

If I am accurate in these observations, we are authorized to deduce this important conclusion :—that these vessels which we see running through the vitreous humour and capsule of the lens, and which are sometimes seen filled with red blood or injected with size and vermilion, are not the vessels of the humours, but vessels in their passage to the membrana pupillaris, and that they disappear totally when that membrane is absorbed. They are injected when the membrana pupillaris is injected ; they are more difficult to fill when that membrane is becoming pellucid and tender towards the latter period of gestation ; and with the annihilation of the membrane follows the disappearance of the vessels carrying red blood through the transparent humours of the eye.

In confirmation of the total annihilation of these central vessels of the vitreous humour, I have found that, when disease comes upon the lens of the adult, the vessels, which are apparent in consequence of inflammation, do not proceed through the old tract from the centre of the optic nerve and through the vitreous humour to the lens, but that they come from the extremity of the retina and laterally, and thence spread over the back of the lens.

An eye, which I had lately an opportunity of examining, confirmed me in this opinion. I assisted my brother in an operation on the eye, in which, the anterior part being diseased, it was cut away. I had soon an opportunity of retiring and examining the parts with Dr. Monro. I observed, then, an opaque spot on the posterior surface of the lens, which was, indeed, in the capsule, and to this spot there came vessels over the margin of the lens from the extremities of the vessels of

the retina; but, in the vitreous humour, there were no vessels to be seen, nor any branches passing into the lens obliquely from behind, as they do in the fœtus.

CHAP. X.

SOME SURGICAL OBSERVATIONS CONNECTED WITH THE ANATOMY OF THE HUMOURS.

I HAVE already mentioned, as the principle of the operation of extracting the lens, that the simple action of the muscles, surrounding the eye-ball, is sufficient to protrude the lens, if the incision of the cornea be of proper dimensions relative to the size of the lens. No doubt, if there have been thickening inflammation and perhaps preternatural adhesions of the membranes surrounding the lens, the operation will necessarily become more complicated; the lens will not glide at once over the cheek when the incision of the cornea is completed. But still, I think, we are not to allow ourselves to consider it as a step of the operation, in any circumstances, that the ball of the eye is to be pressed; because, in that case, the membranes of the lens give way suddenly, and part of the vitreous humour unavoidably is protruded with it, or the edge of the lens is turned obliquely to the pupil, and the vitreous humour escapes by the side of it. It is better to destroy the adhesions with the instrument, and to scratch the capsule of the lens so that it may burst. Whence it is evident that it is necessary, in order to insure the correct performance of the operation of extraction, that the lens should press equally forward on the pupil, and that the pupil should be allowed to dilate. From this it appears, how loose the ideas of those are who can speak of trying first to couch, and if that is not found to succeed, then to perform the operation of extraction. I conceive the attempt with the needle to preclude the operation of extracting, for these reasons:—An unsuccessful attempt to depress will, in general, be a laboured and reiterated motion of the point of the needle, which must occasion inflammation and an adhesion firmer

than is natural. Again, in couching, the lens is removed from the axis of the eye so far only that, in the case of the extracting being attempted, it no longer equally opposes itself to the pupil, the consequence of which must be, the escape of the vitreous humour and the detention of the lens.

In regard to the place at which the couching needle is to be introduced, we may observe, that we are directed, by the older surgeons, to pierce the sclerotic coat very near to the edge of the cornea, because they were afraid of hurting the lens with the needle! The idea then entertained was, that the cataract was a membrane hung behind the pupil and before the lens.—The older surgeons had the idea that the needle entered before the lens, and passed at once into the aqueous humour. We are to disregard these injunctions of surgeons who directed the needle to be introduced with the idea of avoiding the lens; for, while their notions regarding the disease were erroneous, their rules of operating could not be correct: accordingly, we find them differing in their directions as to the place of piercing the cornea; some directing us to pierce it at the distance of one line from the edge of the cornea, others at the distance of four lines and a half.

Now that we know the place of the cataract, and know also that it is the opaque lens, we can be at no loss to introduce the needle correctly. If, says M. Petit, we pierce the sclerotic coat one line from the edge of the cornea, we pierce the tunica conjunctiva, sclerotica, choroid, vitreous humour, and ciliary processes before the needle enters the cataract. In this puncture, we wound the most vascular part, and, indeed, every delicate part of the eye; for even in this most anterior course, the retina is equally lacerated with the others.* But if we pierce the sclerotic coat, three lines from the edge of the cornea, we avoid the ciliary ligament and body, and processes; and, by directing it a little forward, in a line towards the opposite margin of the iris, we shall find the point of the needle advancing through the opaque lens; for, although the lens be so far opaque as to prevent the light from striking the retina, it is so far transparent, in general, that the needle is distinctly seen entering its substance, and can be then directed, so as to transfix the cataract without hurting the iris.

We have seen that there is no posterior chamber of the aqueous humour fit to contain the depressed crystalline lens. The belief, which even some modern surgeons have entertained, of

* In our moſt modern ſyſtem of ſurgery, we are directed to enter the needle one tenth of an inch. To my certain knowledge, not only the ciliary body has been injured by this direction, but even the root of the iris has been ſeen to be puſhed forward on the point of the needle.

the possibility of depressing the lens into the aqueous humour, is a remnant of those inaccurate notions respecting the size of the posterior chamber of the aqueous humour and the place of the lens, which have long been corrected. With this, also, I think ought to have been forgotten, the idea of the rising of the lens after it has been depressed by the cataract floating in the humours.—The fact I am confident is this: when, after transfixing the cataract, we endeavour to dislodge it by depressing the point of the needle, we separate the adhesion between the humours and the points of the ciliary processes; we do not, however, unsocket the lens from the fore part of the vitreous humour, but when the lens descends with the point of the needle, from before the pupil, the vitreous humour revolves with it; the consequence of which is, that when the needle is withdrawn, the lens rolls round with the vitreous humour: but as the lens only is opaque as its firm connexion with the vitreous humour, and even the rolling of the vitreous humour itself cannot be seen, this rolling of the lens appears to be the consequence merely of its own buoyancy in the aqueous humour.—This adhesion of the lens to the vitreous humour, I have been sensible of during its depression, from the elastic nature of the resistance which I felt. When the lens parts from its socket in the vitreous humour, and when it is depressed with such a turn of the needle as puts it under the anterior part of the vitreous humour, it cannot rise again; there is no motion of the eye which can replace it—there is no aqueous fluid in which, if it were of less specific gravity, it could rise: it lies under and, in part, imbedded in the vitreous humour. Another idea is, that it rises with the needle: but no one, who understands what is to be done in the operation of the needle, will raise it again opposite to the pupil after the lens is depressed—it ought to be withdrawn without again elevating the point. But what has always appeared to me as the most unaccountable cause that can be assigned for the rising of the cataract, is the action of the muscles of the eye.* It has been explained how the lens is protruded by the action of the muscles when the cornea is cut and the aqueous humour let out, for then the uniform resistance of the eye is broken, and there is a motion of the humours towards the breach, and the lens, lying behind the pupil, is the first part to be protruded forward; but when it lies under the anterior part of the vitreous humour (and there it must lie if it is at all displaced,) or in whatever situation it happens to be, from that it cannot be moved by the action of the recti muscles; for they embrace the eye on every side, and their ac-

* See Mr. Benjamin Bell's Syſtem of Surgery.

tion operates uniformly, so that they cannot effect a body immersed in the midst of the humours. For the same reason that we should decline the operation of extracting, after attempts have been made to depress with the needle, I should refuse when the pupil is rugged and irregular, because the disease may be more extensive than it appears to be. Thus cataracts brought on by falls, or blows, or punctures of the eye, are less favourable, as there is danger of the inflammation having gone deep, and having affected the other humours in a way which cannot be known, since the opaque lens is betwixt us and them.

A frequent cause of the failure of the operation of depression is the displacement of the lens backwards; for when it seems to have gone down with the needle, it has slipped from under it and started backward. In this case the pupil appears clear, but the patient gains little advantage; for the cataract, though removed from the pupil, is still in the situation to obstruct the light.

CHAP. XI.

OF THE MANNER IN WHICH THE EYE ADAPTS ITSELF TO THE DISTANCE OF OBJECTS.

THIS is a question which many have endeavoured to determine, and many have failed; the proof of which is, that there is not *one* explanation of the manner in which the eye adapts itself to the distance of objects, but *many* explanations equally ingenious.

One opinion is, that the eye is at rest when we see the distant parts of a landscape, but that the direction of the eye to the nearer objects is attended with an effort. This effort is the action of the straight muscles of the eye compressing the ball of the eye, so as to lengthen the axis as much as is necessary to allow the pencils of rays to unite in points upon the retina.

To this opinion it is objected, that in some animals the sclerotic is hard, and not capable of changing its figure; that in man, the pressure would be unequal; that the unelastic

retina would be thrown into irregular folds; that these muscles, being voluntary muscles, under the will, we should be more conscious of their operation than we are; and that, while the mind remains attentive to distant objects, no voluntary exertion of these muscles can effect the distinctness of the objects. Again, to make the eye change its accommodation from the distinct vision of objects, at six inches to fourteen feet five inches, would require such a pressure as might lengthen the axis of the eye one tenth part, which again would form an oval that would derange the retina.

Another opinion is, that when the eye sees the nearest objects it is at rest; and that, in attending to distant objects, the straight muscles draw back the fore part of the eye into the socket, and thus shorten the axis. To this opinion, of course, the same objections lie as to the supposition that the axis is lengthened by the operation of the muscles.

There are some who have entertained an opinion, that the iris, by its contraction, operates so on the circular margin of the cornea, where it is connected with the sclerotic coat, as to make the cornea more convex, and thus increase its power of concentrating the rays and enable the eye to see near objects distinctly. To account for this power in the iris, Dr. Jurin, the proposer of this hypothesis, supposes that there is a greater muscular ring in the margin of the iris connected with the edge of the cornea: the existence of these muscular fibres is not demonstrated, but he says, since the lesser muscular ring in the inner margin of the iris is not proved by ocular inspection, and yet is justly inferred from its effects, viz. the contraction of the pupil; in the same way, "the change of conformation in the eye has not yet been adequately accounted for, but may be fairly made out by supposing the existence of the greater muscular ring." His conclusion is in these words:—"When we view objects nearer than the distance of 15 or 16 inches, I suppose the greater muscular ring of the iris contracts, and thereby reduces the cornea to a greater convexity; and when we cease to view these near objects, this muscular ring ceases to act, and the cornea, by its spring, returns to its usual convexity suited to 15 or 16 inches. In which condition the elasticity of the cornea on the one side, and the tone of the muscular ring on the other, may be considered as two antagonists in a perfect equilibrium."

To this opinion it is objected, that the iris is not rooted in the cornea, but in the sclerotic coat, which is firm in man and inflexible in many animals. We have also to consider, that this delicate and invisible circle of muscular fibres has not only to contract the margin of the cornea, but, in this action, to

alter the configuration of the whole eye. The eye-ball is a whole equally distended, and no part of it can suffer contraction without a resistance from the whole of the coats: besides, in this case, the alternation of light and the brightness of objects would be perpetually obscuring the image, by the play of the iris causing an alteration of the focus of the cornea. But Dr. Jurin did not attribute the whole effect to the action of the iris. He thus explains the use of the fluid surrounding the lens and the membranous capsule:—When the eye is to be suited to greater distances, he supposed that the ligamentum ciliare contracts its longitudinal fibres, and, by that means, draws the part of the anterior surface of the capsule, into which these fibres are inserted, a little forward and outward. By this action, he supposed that the fluid, within the capsule of the lens, flows from the middle towards the margin; and, consequently, the centre of the capsule of the lens is reduced to a less degree of convexity; and that the elasticity of the capsule, and the tone of the ligament, may be looked upon as two antagonists perfectly in equilibrio with one another. In the state of rest, the eye is conceived, by Dr. Jurin, to be adapted to the middle distance; by the increase of the convexity of the cornea, to be adapted to nearer vision; and by the change in the capsule of the lens, to be fitted to distant objects.

To this last supposition it is objected, that there is a simplicity in the operations of nature; that the change, wrought upon the capsule of the lens, is insufficient to account for the whole effect, and that, therefore, there is a presumption that it has no share in producing the change; that there are no muscular fibres in the ciliary processes; and, lastly, that this fluid, being of density but little, if at all, removed from the aqueous humour, any alteration of its form can have but a very insignificant effect.

It has occurred to others*, that the oblique muscles of the eye-ball, being thrown in opposite directions round it, they may have the effect of elongating the axis of the eye. Again, that the action of the orbicularis muscle of the eye-lids, by compressing the eye-ball, assists in accommodating the eye for seeing near objects more distinctly. Dr. Monro makes a set of experiments to prove the effect of the orbicularis muscle of the eye-lids; but I conceive that he has deceived himself, in ascribing to the compression of the eye-lids an effect partly produced by a voluntary effort, but in a way which is is not understood, and partly by the contraction and dilatation

* Hambergerus, Briggs, Keil, Monro.

of the pupil, from the degree of opening of the eye-lids. If he be right in his way of accounting for the effects produced in the experiments which he details, they ought to have the effect of precluding the necessity of all further hypothesis; so fully does the action of the orbicularis muscle seem to him adapted to the end proposed. In the first experiment, when he opened his eye-lids wide, and endeavoured to read a book the letters on which were so near the eye as to be indistinct, he found that he could not do it. In the second experiment, keeping the head in the same relation to the book, he brought the edges of the eye-lids within a quarter of an inch of each other, and then made an exertion to read, when he found he could see the letters and words distinctly. When I try this experiment, I find the action of the eye-lids to have no sensible effect, unless they are brought very close together: then, I do indeed find that they have a most remarkable effect. But in this situation, the eye-lids cover the cornea so much, that if they have any effect at all upon the cornea, it must be to compress and flatten it, and not to give it a greater convexity. The smaller the opening of the eye-lids, the greater I found the effect. I conceive it to be produced by the optical effect of the eye-lashes correcting the too great converging of the rays; and the same effect I found to be produced by the marginal hairs of two flat camel-hair brushes, although the eye-lids were kept open. Dr. Monro concludes that, in this action of the eye, 1st, the iris, 2dly, the recti muscles, 3dly, the two oblique muscles, and, 4thly, the orbicularis palpebrarum, have all their share in accommodating it to the distance of objects, and in giving perfect vision.

Very ingenious experiments are made by Dr. Young,* to determine whether there be any change in the length of the axis of the eye-ball. He considers it as necessary, to account for the power of the eye in adapting it to the distance of objects, that the diameter should be enlarged one seventh; its transverse diameter diminished one fourteenth; and the semi-diameter shortened one thirtieth of an inch. To determine this he fixed the eye, and at the same time he forced in upon the ball of the eye the ring of a key, so as to cause a phantom very accurately defined to extend within the field of perfect vision; then looking to bodies at different distances, he expected, if the figure of the eye was altered, that the spot, caused by the pressure, would be altered in shape and dimensions; he expected that, instead of an increase of the length of the eye's axis, the oval spot caused by the pressure of the key, resisting

* Philos. Trans. for 1801.

this elongation, should have spread over a space at least ten times as large as the most sensible part of the retina: but no such effect took place; the power of accommodation was as extensive as ever, and there was no perceptible change either in the size or in the figure of the oval spot. Again, he placed two candles so as exactly to answer to the extent of the termination of the optic nerve; he marked accurately the point to which the eye was directed; he then made the utmost change in its focal length: expecting that, if there were any elongation of the axis, the external candle would appear to recede outward upon the visible space: but this did not happen; the apparent place of the obscure part was precisely the same as before.

A favourite opinion of late has been, that the lens has a power of altering its degree of convexity, and thus accommodating itself to the distance of objects. As to the fibrous structure of the lens, there can be no doubt: first it is rent by fissure, then split into lamina, and can be finally teased out into fibres.

This structure was first observed by Leewenhoeck: he has these words:—"Porro vidi corpus crystallinum ex tam tenuibus coacervatis constare squamis ut ubi eas oculo dimetior, dicere cogar, plures bis millenis sibi invicem incumbere; ubi enim corpus crystallinum ab ejus membranula seperassem, ejus adhuc axis, ubi crassissimum erat, (non enim est perfecte rotundum, sed aliquo modo planum) duas tertias pollicis partes retinebat; ergo a centro ad circumferentiam est tertia pollicis pars atque quoniam, ex dimensione mea, 600 pili lati pollicis quadrati, longitudinem conficiunt 200 pili lati pollicis tertiam partem adæquare debent. Atque nunc video ubi denæ squamæ sunt coacervatæ, eas capilli nostri diametrum nondum adæquare; ergo his 10 cum 200 multiplicatis, sequetur, ut dictum, plures 2000 squamas in corpore cristallino esse coacervatas.—Porro vidi singulas has squamas ex filamentis, concinno ordine juxta se positis, constare adeo ut singulæ squamulæ unum filamentum sint crassæ; & ut hanc substantiam fibros eam ex qua corpus crystallinum constat ob oculos ponerem, eam, lineis in circulum ductis quantum pote designavi."

The fibrous structure and muscularity of the lens was brought forward by Descartes, as explaining some actions of the eye; but was again neglected, till more lately, that it has been revived by the insertion of Mr. Young's observations on vision in the Philosophical Transactions.* The following are Mr. Young's observations on the appearance of the lens:—"The crystalline lens of the ox is an orbicular convex trans-

* See vol. for 1793.

parent body, composed of a considerable number of similar coats, of which the exterior closely adhere to the interior.—Each of these coats consists of six muscles, intermixed with a gelatinous substance, and attached to six membranous tendons. Three of the tendons are anterior, three posterior; their length is about two thirds of the semi-diameter of the coat; their arrangement is that of three equal and equidistant rays, meeting in the axis of the crystalline; one of the anterior is directed towards the outer angle of the eye, and one of the posterior towards the inner angle, so that the posterior are placed opposite to the middle of the interstices of the anterior; and planes passing through each of the six, and through the axis, would mark on either surface six regular equidistant rays. The muscular fibres arise from both sides of each tendon; they diverge till they reach the greatest circumference of the coat, and having passed it, they again converge till they are attached respectively to the sides of the nearest tendons of the opposite surface. The anterior or posterior portion of the six viewed together, exhibits the appearance of three penniform-radiated muscles. The anterior tendons of all the coats are situated in the same planes, and the posterior ones in the continuations of these planes beyond the axis. Such an arrangement of fibres can be accounted for on no other supposition than that of muscularity. The mass is inclosed in a strong membranous capsule, to which it is loosely connected by minute vessels and nerves; and the connection is more observable near its greatest circumference. Between the mass and its capsule is found a considerable quantity of an aqueous fluid, the liquid of the crystalline."

Fibrous Structure of the Lens.

Fig. 14.

Mr. Young's figure.

Fig. 15.

Leeuwenhoek's figure.

Supposing that these are muscular fibres, from their closeness and direction, they would stand acknowledged as forming the strongest and most powerful muscle of its size in the whole body; yet they act only on themselves, which requires the least possible degree of power. Again, how are they relaxed? What power is their antagonist? Mr. Young demonstrates not only the muscular fibres, but the tendons of the lens;* as if it were not evident that the lens acted merely on itself, which could require no concentrating of its fibres into tendons; for tendons are found in other parts of the body only where it is necessary to concentrate the whole power of the muscle so as to operate on one point.

We learn from Mr. Home,† that Mr. John Hunter had proved the lens to be laminated, and those laminæ to be composed of fibres; and, upon the same authority, we learn that his opinion was in favour of the muscularity of its structure.—Mr. Home wished to follow out this subject, by including it in the Croonian Lecture. Mr. Home found, with the assistance of Mr. Ramsden, that a patient, after the extraction of the cataract, still retained the power of adapting the eye to the distances of objects. Indeed, we must be well aware that if a patient, after couching and extracting the lens, could only see at one given distance, an effect so very particular must have been long since observed. This was a conviction to Mr. Home and Mr. Ramsden, that the investigation was to be no further pursued in this tract, and they turned their attention, therefore, to the cornea.

Mr. Ramsden contrived an apparatus which, if the gentlemen engaged in the experiments have not deceived themselves, must put this question at rest. By Mr. Ramsden's ingenious contrivance, the head was fixed accurately, and at the same time a microscope was adapted to observe the changes in the convexity of the cornea as the eye was directed alternately to near and to distant objects. In these experiments, the motion of the cornea became distinct, its surface remained in a line with a wire which crossed the glass of the microscope when the eye was adjusted to the distant objects, but projected considerably beyond it when adapted to the near ones, and the space through which it moved was so great as readily to be measured by magnifying the divisions on the scale, and comparing them. In this way, it was estimated that it moved the 800th part of an inch (a space distinctly seen in a microscope magnifying 30 times,) in the change from the nearest point of distinct vision to the distance of 90 feet.

* See Philof. Tranf. † Ibid.

In the evidence from anatomical structure, I cannot think Mr. Home so happy. He was desirous of determining, more accurately than had hitherto been done, the precise insertion of the tendons of the four straight muscles, so as to know whether their action could be extended to the cornea or not: he found them to approach within one-eighth of the cornea before their tendons became attached to the sclerotic coat. But he did not stop here—he stripped off with them the anterior lamina of the cornea. Now, as it is supposed, in these experiments, that the action of the recti muscles upon the sides and back part of the ball compresses the humours, and makes them flow forward so as to distend the cornea; if the extremities of the tendons be inserted into the edge of the cornea and even pass over it, as Mr. Home has demonstrated, their effect would be to flatten the cornea, by drawing out and extending its margin. This is a circumstance which Dr. Monro has remarked; and Dr. Monro has also, with more accuracy of observation, found "all the tendinous fibres of the recti muscles firmly attached to the sclerotic coat at the distance of a quarter of an inch from the cornea, and no appearance that any part of them, or that any membrane produced by them, is continued over the cornea."

Amongst the variety of opinions, the innumerable ingenious but contradictory experiments for discovering the manner in which the eye adapts itself to the distance of objects, I am, for my own part, much at a loss to determine which I should prefer. I have often doubted, whether these experiments were not in search of the explanation of an effect which has no existence. I have never been able to determine, why a very slight degree of convexity in the cornea of a short-sighted eye should be so permanent during a whole life-time, notwithstanding the perfect elasticity of the cornea, and its being so adapted as to alter its convexity by the action of the muscles.—Again, a near-sighted person, with the assistance of a concave glass, can command the objects to the distance of some miles, and with the glass still held to his eyes, can see minute objects within three inches of the eye. Now, I cannot conceive how the concave glass should give so great a range to the sight: as there can be no change in the glass, it must be the eye which adapts itself to the variety of distances; yet, without the glass, it cannot command the perfect vision of objects for a few feet. Again, a short-sighted person sees an object distinctly at three inches distant from his eye; at 12 feet, less distinctly: and when he looks upon the object at 12 feet, the objects beyond it are confused, just as in other men's eyes; but when he directs his attention to the more remote objects, those nearer become

indistinct. Now this indistinctness of the object, seen when he examines narrowly the objects beyond them, would argue, (did we admit this muscular power in the eye of adapting itself to objects,) that the cornea or the lens has become less convex, were we not previously convinced that the utmost powers of the eye could not bring the object at the distance of 12 feet, or any other intermediate distance, to be more distinctly seen than the fixed and permanent constitution of the eye admits.

I cannot help concluding, therefore, that the mechanism of the eye has not so great a power of adapting the eye to various distances as is generally imagined, and that much of the effect attributed to mechanical power is the consequence of attention merely. An object looked upon, if not attended to, conveys no sensation to the mind. If one eye is weaker than the other, the object of the stronger eye alone is attended to, and the other is entirely neglected : if we look through a glass with one eye, the vision with the other is not attended to. Now objects, as they recede from us, become fainter and fainter in their colours, and the general effect upon the eye is different from those which are near; and as it happens that the mind must associate with the sensation before it be perfect, there is, consequently, an obscurity thrown over distant objects when we contemplate near ones; as, on the other hand, the images of near ones are not attended to when the mind is occupied with distant ones, although they be nearly in the line with the distant object examined. I conceive it to be a good deal like that command of the attention which we can exercise upon very small bodies near us: of two small grains lying on the table, we can examine the one and neglect the other; though, if we attend to both, we can take them in to the sphere of perfect vision; or, in other words, though they both have their images on the more sensible part of the retina. We can attend to one letter of a word, to the whole word, or to the page of a book. I cannot altogether deny the mechanical power of the eye in adapting it to the distance of objects, but I think this operation of attention has been too much overlooked.

CHAP. XII.

OF SEEING IN GENERAL.

THE eye is certainly the noblest of the organs of sense. It is that with which we should part the most unwillingly, and of which, when deprived, we are most helpless. A celebrated philosopher says, how much more noble is that faculty by which we can find our way in the pathless ocean, traverse the globe, determine its figure and dimensions, delineate every region of it; by which we can measure the planetary orbs, and make discoveries in the sphere of the fixed stars! Again, how admirable is that organ by which we can perceive the temper and dispositions, the passions and affections of our fellow creatures; and, when the tongue is taught most artfully to lie and dissemble, the hypocrisy is discovered in the countenance! we often are able to detect what is crooked in the mind as well as in the body! Yet, notwithstanding the perfection of the sense of seeing, much of this perfection is gained by the other senses, and particularly by that of touch. If the human body were motionless and inert, the sensation conveyed by the eye would be very imperfect; we should be able to conceive neither the distance nor the figure of objects. But, as it is the distance of the object, joined with its visible magnitude, is the sign of its real magnitude; and the distance of the several parts of an object, joined with its visible figure, becomes a sign of its real figure. Without this combination of the original sensation with the acquired perception, we should see form and colour without having any idea of its distance, or of the convexity of an object; we should have no measure of its length, or breadth, or distance.

Upon other occasions, we are apt enough to acknowledge the powers of association. But the connection of ideas is in no instance more constant and secret than in the ideas conveyed by sight and touch. When a solid body is presented to view, we see only the light and shade; but this raises in our mind the associated ideas from the sense of touch, viz. solidity, convexity, and angularity, "the visible idea exciting in us those tangeable ideas," which, in the free and promiscuous exercise of our senses, usually accompany it. It is thus that

we attribute to the sense of sight what is the act of the memory and judgment*.

We have seen that the picture of an object is formed in the bottom of the eye. It was formerly sufficient to say, that the mind contemplates this image. We should say now, that this image is conveyed into the sensorium by the optic nerve. This is an hypothesis merely; and we have no more consciousness of the object being in the brain or sensorium than in any other part of the body: we may rather say, that the impression made on the organ, nerves, and brain, is followed by sensation, and that the intelligence is the joint operation of the whole†. Lastly, the metaphysician calls our sensations the signs of external objects; because the object itself is not presented to the mind, nor is there an actual resemblance betwixt the object and the sensation of it, but merely a connection established by nature, as certain features are natural signs of anger; or by art, as articulate sounds are the signs of our thoughts and purposes.

We are now naturally led to the consideration of some points, the full comprehension of which, requires the knowledge, both of anatomy and of the principles of optics.

PARALLEL MOTION OF THE EYES.

The axis of the eye is a line drawn through the middle of the pupil and of the crystalline lens, and which consequently falls upon the middle of the retina; and the axis of both eyes produced, are called the optic axis. But the axis of the eyes, it is evident, are not always parallel; for when both eyes are directed to a near object, the axis of the eyes meet in that object; but when we direct the eyes to the objects in the heavens, they may be considered as perfectly parallel in their axis, though perhaps not then mathematically so. To an observer, the eyes seem always moving in parallel directions; but nature has given us the power of varying them so, that we can direct them to the same point, whether remote or near. This, how-

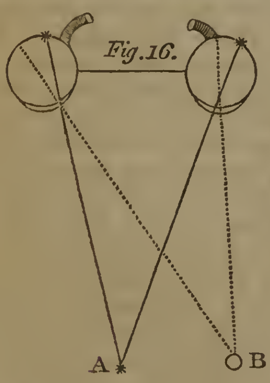
* See Dr. Jurin of Mr. Molyneux's problem, Smith's Append. p. 27.

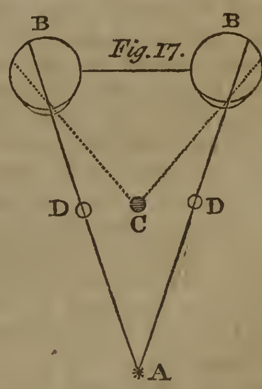
† Euclid, and others of the ancients, contended that viſion was occaſioned by the emiſſion of rays from the eye to the object. He thought it more natural to ſuppoſe, that an animate ſubſtance gave out an emanation, than that the inanimate body did. In 1560, the opinion was confirmed that the rays entered the eye.—The ſenſation was not always believed to be in the retina: It was by ſome believed that part of the ſenſation was to be attributed to the cryſtalline. Kepler, in 1600, ſhewed, geometrically, how the rays were refracted through all the humours of the eye, ſo as to form a diſtinct picture on the retina; and alſo he ſhowed the effect of glaſſes on the eyes. See further, regarding the opinions of the ancients, Boerhaave Prelect. Acad. tom. iv. p. 282.

ever, is in some measure learnt by custom, and lost by disuse. A child has much difficulty in altering the distance of its eyes, which is the occasion of the vacancy of its stare : and again, we observe that a patient who has long lost one eye, is incapable of directing the axis of the blind eye without looking with the other, and even then, the blind organ does not follow the other with that perfect accuracy which exercise gives when both eyes are sound. By much practice and straining, the axis of the eyes may be much further altered from the natural parallelism, which wags and boys often do, so as to distort the eyes, and give a droll obliquity to the countenance.

Still, custom alters the direction of the axis of the eyes but a very little ; for the natural constitution of the eye does not allow the child to turn his eyes in every different direction from each other. There is, on the contrary, as we have seen, a particular sensible spot in the retina, which makes it necessary to distinct vision, that this spot shall receive the concentrating rays of light ; and the natural constitution of both eyes, is, that this spot in each eye shall have such a relation to that of the other, that the axis of both should be accurately in the middle of the eye-ball in order to produce single vision.

By voluntary squinting or depressing one of the eyes with the finger, objects appear double, because the optic axis is changed in the distorted or depressed eye, and the picture is no longer painted on corresponding points of both. This simple experiment leads us to consider what is the constitution and correspondence of the eyes, that, when each has the picture of the object impressed upon it, we should only see it single if the eyes are sound and perfect.





For example, the object A, in fig. 16., is exactly in the centre of the axis of both eyes ; consequently, it is distinctly seen :

and it appears single, because the rays from it strike upon the points of the retina opposite to the pupils in both eyes. Those points have a correspondence; and the object, instead of appearing double, is only strengthened, in the liveliness of the image. Again, the object B will be seen fainter, but single, and correct in every respect. It will appear fainter, because there is only one spot in each eye which possesses the degree of sensibility necessary to perfect vision: and it will appear single, the rays proceeding from it having exactly the same relation to the centre of the retina in both eyes. Though they do not fall on the centre of the retina, they fall on the same side of the centre in both eyes. But if the eyes are made to fix steadfastly on an object, and if another object should be placed before the eyes within the angle which the axis of the two eyes make with the first object, it will be seen double, because the points of the retina struck by the rays proceeding from the nearer object do not correspond in their relation to the central point of the retina. Thus, the eyes B B, fig. 17., having their axis directed to A, will see the object C double somewhere near the outline D D. Because the line of the direction of the rays from that body C, do not strike the retina in the same relation to the axis A B in both eyes. Upon this principle, we may easily explain why objects, which are much nearer the eyes, or much more distant from them than that to which the two eyes are directed, appear double. Thus, if a candle is placed at the distance of ten feet, and I hold my finger at arm's length between my eyes and the candle, when I look at the candle, I see my finger double, and when I look at my finger, I see the candle double. This double vision occurs to us all frequently; but, unless we make the experiment purposely, we do not attend to it. Many other instances of the harmony, and of the want of it in the eyes, particularly the reverse of what these diagrams shew, may be easily produced, viz. the seeing two objects single: for, if we look at a half-penny and a shilling, placed each at the extremity of two tubes, one exactly in the axis of one eye, and the other in the axis of the other eye, we shall see but one piece of coin, and of a colour neither like the shilling nor like the half-penny, but intermediate, as if the one were spread over the other.

This relation and sympathy between the corresponding points of the two eyes, is, therefore, to be considered as a general fact, viz. that pictures of objects falling upon corresponding points of the two retinas, present the same appearance to the mind as if they had both fallen upon the same point of one retina; and pictures upon points of the two retinas which do not correspond, and which proceed from one

object, present to the mind the same apparent distance and position of two objects, as if one of those pictures were carried to the point corresponding with it in the other retina.

Several animals, we see, direct their eyes by very different laws from those which govern the motion of ours: but we are not to reason upon their sensations by the laws of vision of the human eyes; we must take it as a principle, that nature has been bountiful to them also; and that the result of organization in their eyes is perfect vision.

In birds, (if we except the owl,) the eyes diverge, and are directed to opposite sides. As the owl seeks his prey in the night, it may be necessary to the distinctness of his vision in weak light, that both eyes be directed to the object. Most fishes have their eyes directed laterally, though there are exceptions; as those fishes which are flat, and swim at the bottom, have their eyes directed upward. In many insects, the surface of the eye has no resemblance to the cornea of viviparous animals; but when examined with the microscope, it is seen to consist of a number of tubercles, each of which is as a distinct eye. In others, the eye is removed to the extremity of the moveable tenaculæ. Very large animals, as the whale, elephant, rhinoceros, hippopotamos, have, in proportion to their bodies, very small eyes: so have the animals which live much under ground; and, in general, a large eye is a sign of the animal being able to see in obscure light, because there is proportionably a greater number of rays admitted into the eye. For the same reason, fishes have a peculiarly large eye and dilatable pupil, because the water is a more obscure medium, and, from the occasional roughness of its surface, much darkened and variable.

We must conclude, that in these varieties of the eyes, where there is a difference in number, position, and natural motion, there are different laws of vision adapted to these peculiarities and the exigencies of the animals. If we are to judge from analogy, we may suppose, that in many animals, there is no correspondence between points of the two retinas, or it is of a different kind from ours. In those which have immoveable eyes, the centre of the two retinas will not correspond so as to give the idea of one object, but of distinct objects, and in their respective places. In other animals, corresponding points would give false appearances; and in such as turn their eyes in all directions, independently of each other, they would seem to possess a perception of the direction in which they move them, as we have of the motion of our arms.

SQUINTING.

We have seen, that there is a point in both retinas more acutely sensible to the impression of light and the image of objects, than any other part of all its concave surface. In a sound eye, this point is immediately opposite to the pupil.—There is a coincidence betwixt this point and the axis of the eye; and when we look to an object, its image strikes this point of the retina: but if it should happen that this sensible point of the retina should be changed, and not be exactly opposite to the pupil when the axis of the eye is in the line with the object, there will be an effort of the muscles moving the eye-ball to turn, so that the rays proceeding from the object shall strike upon the more sensible spot of the nerve.* Again, if the greater sensibility of the nerve should lie in its proper place, and a remote cause should occasion such an action of the muscles and distortion of the eye as we see in a squint, then the image will be double; for it no longer falls on corresponding points of the retina of each eye, and separate images are conveyed to the brain. If, however, this distortion continues, the single vision is gradually restored. Is there, then, in this case produced a new correspondence betwixt points of the retina which were before discordant? We find that this is not the case, by a very simple experiment.—In a person who squints, one of the eyes is directed to the object and the other appears to be turned from it: if the sound eye be shut, and the person be directed to look to an object with the other, it is directed to it with the proper and natural axis. Now this shows us that the sensibility of the proper spot in the bottom of the eye is not lost.—We must explain the single vision in eyes, one of which is distorted from its natural axis, upon another principle. Most people who squint, have a defect in one eye, and this is the distorted eye, while the other is directed in the true axis to the object. Now the mind does not attend easily to two impressions, the one being weaker than the other: in a short time the weaker impression is entirely neglected, and the stronger only is perceived.—So in squinting, the impression on the weak eye in a short time ceases to be attended to, the strong and vivid impression is alone perceived, and single vision is the consequence. It is evident, then, that those who squint must have a degree of imperfection in the strength of

* This was M de la Hire's opinion.—He had an idea alſo that ſquinting was produced by the obliquity of the object. Both of theſe opinions are refuted by Dr. Jurin.

the image; for it is necessary to neglect the impression of one eye, to obtain distinct vision with the other; the consequence of this is frequently an attempt still further to distort the eye, and turn it so far inward or under the upper eye-lid that no distinct impression can be received upon it: at all events, they perceive the object only with one eye, although they may be said to see it with both; the perception being the combined operation of the organ and of the mind.

If the sensation of one eye be weak, it is very liable to be neglected altogether, and that eye is apt to wander from the true axis; and if the person be careless, or given to distort his eyes in childishness, a permanent squint may be given to the eyes.

Another cause of squinting, in children, is the being so laid in their cradle, that the light strikes obliquely into one of the eyes, whilst the other cannot see it; by which means one of the eyes only comes by degrees to be directed to the light while the sensation of the other is disregarded. What is very extraordinary in squinting, is the correspondence in the muscles of the eye, notwithstanding the great distortion of the eye-ball; for, when both eyes are open, as the sound eye turns in all variety of directions to the surrounding objects, the other eye still follows it, but preserves its distance, so as in a manner to avoid all interference. Blows on the head, drinking and smoaking, and a variety of irritations, occasioning convulsions and distortion of the eyes, cause double vision. As this is evidently produced by the affection of the muscles moving the eye-ball,* since any change upon the retina could not give occasion to such distortions in a state of insensibility, we may naturally conclude, that squinting is sometimes the consequence of irregular action of the muscles; for if those transient causes are apt to affect them, so will they be apt to be permanently affected.†

* The command of the voluntary mufcles is firft loft in intoxication; and, therefore, it is more likely that the mufcles fhould lofe their natural action and correfpondence than the retina.

† In Smith's Optics, there is a cafe of fquinting and double vifion occafioned by a blow. In Buffon's Differtation, in the Acad. Roy. des Sc. 1743, fquinting after long continued pain of the head. In the Mem. Roy. de l'Acad. des Sc. 1718, Hift. p. 29, there is a curious inftance of falfe vifion. I find alfo quoted feveral cafes of ftrabifmus from fudden fright, in *Ephem. Germ. cent* 3 & 4. *obf.* 152. *p.* 349. Ib. dec. 3. an. 8 & 11 ob. 57. p. 114. Ib. dec. 3. an. 9 & 10. obf. 67. "Novi Juvenem paralyfi obnoxium, cui cum cæteris oculi finiftri mufculis relaxatis, *adducens* fortius contraherctur propter oculum ita diftortum objectum quodcunque duplex apparebat, nec quod verum effet diftinguere poteft." *Willis de anima Brut. P. Phyfiol.* p. 77. An inftance of the lofs of correfponding motions of the eyes, and ftrange illufions of fight. See in the Inquiry into the nature of mental derangement by Dr. Crichton, vol. i. p. 147.

We can distort our eyes by an unnatural effort, but we cannot squint: that is to say, we can bring our eyes into such a forced situation that we cannot see any thing distinctly; but we cannot keep one eye distinctly upon an object and turn the other from it.—Such a position of the eyes, at least (and which is exactly that of those who squint unintentionally,) I cannot, by any means, accomplish.‡ This shows the strict correspondence betwixt the moving muscles of the eye-balls. By this experiment, we shall find the difficulty of that method of correcting the squint proposed by Dr. Jurin, or of commanding motions of the eyes different from those which have been bestowed by nature, or acquired by habit. But habit I believe to be much more seldom the origin of squinting than is generally supposed. It is said, by Dr. Reid and others, that we see young people, in their frolics, learn to squint, making their eyes either converge or diverge when they will to a very considerable degree: why should it be more difficult for a squinting person to learn to look straight when he pleases? The reason of the greater difficulty is obvious, that in making the eyes converge or diverge, the will is acting upon both eyes equally; but to distort one eye inward or outward, and at the same time to keep the other fixed, is to me like an absolute impossibility. Most people, who squint, have a defect in the distorted eye, a weakness which they do not observe, from want of attention to the impressions upon that eye. It will be difficult to determine whether this defect be an original fault, or the effect of the want of use: since, by tying up the sound eye, the weak one becomes gradually stronger, so that the person becomes able to read with it, much may be attributed to the neglect of impressions.

It may be observed, that this neglect of the impressions, which are actually received, is not at all like that disuse, which is the consequence of no impression being received: for darkness increases the sensibility of the retina, while this dissipates and exhausts it. That squinting is not produced by the weakness of the impression received upon the nerve, would appear from the circumstance that opacity of the humours or the gutta serena do not occasion an alteration of the usual correspondence in the muscles moving the eye-balls.

It is said, that in those who have lost the sight of one eye, the habit of directing it to the object they look at is lost, because this habit is no longer of use to them.† This I have

* It is ſaid that aſtronomers, who are much uſed to attend only to the impreſſions of one eye, are ſometimes able to ſquint at pleaſure. See Mr. Home Phil. Tranſ. 1797, p. 17.

† Dr. Reid.

never observed, nor should I think it apt to happen, unless the muscles of the eye had been injured from the same cause which destroyed the sight; at any rate, it is in a very imperfect degree, and not such as we should call a squint.

In regard to the cure of squinting, it seems the most reasonable, in the first place, to endeavour to strengthen the weak eye by use, and by tying up the sound one. In this case, the distorted eye becomes properly directed to the object, and the strength of the impression is in some degree restored. When this has been persevered in for some time, and the person is allowed to look at any object with both eyes, the weak eye will perhaps be again distorted from the true axis; but, probably, with a painful effort and double vision: which shows some progress in the recurrence of the two eyes, and their proper sympathy, and that the impression on the weak eye is at least attended to. After this, it will be time enough, by Dr. Jurin's method, to endeavour to correct the squint:—"place the child before you, and let him close the undistorted eye, and look at you with the other. When you find the axis of this eye fixed directly upon you, bid him endeavour to keep it in that situation, and open his other eye. You will now immediately see the distorted eye turn away from you towards his nose, and the axis of the other will be pointed at you. But with patience and repeated trials he will, by degrees, be able to keep his distorted eye fixed upon you, at least for some little time after the other is opened. And when you have brought him to continue the axis of both eyes fixed upon you, as you stand directly before him, it will be time to change his posture, and to set him first a little to one side of you and then to the other, and so to practise the same thing; and when, in all these situations, he can perfectly and readily turn the axis of both eyes towards you, the cure is effected. An adult person may practise all this with a glass, without any director, though not so easily as with one.—But the older he is the more patience is necessary. About twenty years ago, I attempted a cure, after this manner, upon a young gentleman about nine years of age, with promising hopes of success; but was interrupted by his falling ill of the small-pox, of which he died."

Dr. Jurin preferred this method to the use of tubes or shells with small holes in them, which have been recommended.—But what appears to me the great difficulty, lies in the strength of the impression received upon the sound eye, which, causing the impression of the weak eye to be entirely neglected, it is again thrown out of the line of direct vision. I conceive it, therefore, to be a necessary part of the experiment with tubes or shells, that the vision through the tube, applied to the sound

eye, shall be so obscured as to have some accordance with the lesser sensibility of the weak eye, and then, objects being seen equally with both eyes, a gradual accordance of the muscles may be produced. The conviction of the necessity of giving an equality to the strength of the sensation of both eyes must have struck M. de Buffon, since he says, in his Dissertation in the Academy of Sciences, that a plane glass should be applied to the weak eye and a convex one to the strong eye, so as to reduce the last to a state less capable of acting independently of the other.

But what is called a weakness, is very frequently, I am convinced, merely a short-sightedness in one eye: what the effect of this should be we may experience if we look to an object with both eyes, but with one of them through a concave or convex glass; if we are looking upon a book, there will be produced a confusion of the letters, but, by a little practice, the letters will become again distinct. By an attentive observation, we shall find that this is the consequence of attending solely to the impression received in the naked eye: nay, what is still more strange, we can attend, in this experiment, to the impression upon the point of the axis of one eye, and to the general impression of both. If, while looking upon the letters of a large page, I move the convex glass of a small degree of power sideways before my right eye, the whole letters of the page seem to move, leaving distinct and stationary a circular spot containing a word or two. Here, by no effort, while I look with both eyes, can I lose the steady and distinct sight of these few words, because their image is received upon the more sensible central point of the retina of my left eye: but all the other part of the sphere of vision I can see alternately, dimmed or distinct, as I choose to attend to the less powerful impression of the right eye, or the natural sensation of the left. We see, by this experiment, how easy it is to neglect the impression of one eye, if it be no stronger than that of the other (and of course more easily if it be weaker), and how impossible it is to neglect the more vivid impression.

From such a radical defect in the vision, as the humours of one eye having a different focus from the other, and consequently an indistinctness of vision produced from two images of different sizes intermingling their colours, children seem very frequently to be made to squint; and I have known adults, with a degree of the same inequality in the eyes, kept from squinting only by a particular attention to the direction of their eyes. M. de Buffon, in his Dissertation already quoted, after affirming what has been already delivered, viz. that no one squints with both eyes at once, says, he has observed three

instances in which the eyes, according to circumstances, were alternately distorted from the object. This he accounts for by finding that, with one eye, the letters of a book could be seen at the distance of two or three feet, and not nearer than fifteen inches; while, with the other, the letters could be distinguished at the distance of from four to fifteen inches only. Consequently, when looking to distant objects, the image being more distinct with the long-sighted eye, the other was turned from the object; but when objects at a small distance were seen, the image in the far-sighted eye being imperfect, it is turned from the axis, that it may not interfere with the stronger image of the other eye, which is now directed to the object.

A frequent effect of the weakness left by long fevers in children, is a squint which gradually goes off as the strength is restored. It is observed, also, that squinting and double vision are, in some fevers, a concomitant with delirium and phrenitis. This symptom proceeds, in all likelihood, from an unequal tension of the muscles of the eye-ball. The double vision is the effect of discordance in the action of the muscles.

CHAP. XIII.

OF THE EYE-LIDS, OF THEIR GLANDS, AND OF THE COURSE OF THE TEARS.

HAVING completed the description of the eye, as the organ of vision, we have now to attend to its connections, its adventitious membranes, the glands of the eye-lids, and the course of the tears. It is plainly necessary that the eye should not be loose in the socket; but that, in its rolling motion, it should still be attached; and that, although the delicate anterior surface must be exposed, the internal parts of the socket should be defended from the intrusion of extraneous bodies. This is accomplished by the tunica conjunctiva.

The TUNICA CONJUNCTIVA, or ADNATA, is the inflection of the common skin of the eye-lids. It goes a little way back into the orbit, and is again reflected, so as to come forward

and cover the fore part of the eye-ball. Here it is pellucid, and the white coat of the eye shines through it. It covers the cornea also; and here it is perfectly transparent; loses its character of vascularity, as the conjunctiva; and is assimulated to the nature of the cornea. As this coat is a continuation of the common integuments, it is, like them, vascular, and liable to inflammation. The tunica conjunctiva, is the common seat of ophthalmia. In the commencing inflammation, we see the vessels turgid or blood-shot: bye and bye, they elongate towards the surface of the cornea; the patient complains of dimness; the dimness becomes apparent to the surgeon; spots of opacity then form in the cornea; and the vessels of the conjunctiva now take a course over the turbid surface of the cornea. In this stage of the inflammation, by cutting the turgid vessels of the conjunctiva, we interrupt the source of blood for a time, and procure a small evacuation; but these vessels soon coalesce again, and the flow of blood is renewed.

The TUNICA ALBUGINEA is the thin tendinous coat formed by the insertion of the recti muscles, which expand over the anterior part of the eye. I would admit this into the enumeration of the coats of the eye, merely to prevent confusion of names, and to make intelligible the descriptions of some of the older writers. It is not properly a coat. Where the conjunctiva covers the anterior part of the eye, the white sclerotic coat is seen under it; and in consequence of this, the tunica conjunctiva is sometimes called albuginea.

A very material part of the structure of the eye still remains to be described; an apparatus by which the surface of the eye is preserved from injury, kept moist, and perfectly transparent.

The EYE-LIDS are composed of the common integuments, with this difference only, that they have a cartilaginous margin to give them shape, and muscular fibres, in the duplicature of their membrane, to give them motion. A small semilunar cartilage, which lies like a hoop in their edge, keeps them of a regular figure, and so as to close neatly over the eye. This cartilage having a triangular edge, and the base of the angle forming the flat surface of the margin of the eye-lid, they meet with the most perfect accuracy. Either end of this hoop-like cartilage is connected with the periosteum at the corners of the eye, so as to move with its fellow as upon a hinge. This cartilage of the eye-lid is called TARSUS.

The upper eye-lid only, is moved for the admission of light to the eye; it is raised by the levator palpebræ muscle. But the eye-lids are shut again by the orbicularis palpebrarum,

which acts on both eye-lids, and sometimes with such power, as to squeeze the eye-ball even to a painful degree.

The MEIBOMEAN GLANDS. These are very elegant little glands which lie under the inner membrane of the eye-lids.—About twenty or thirty ducts of these glands open upon the tarsus of each eye-lid. These ducts run up under the vascular membrane of the inside of the eye-lid, and minute glandular follicules, to the amount of about twenty, are, as it were, attached to each of these ducts. These glands exude a white sebaceous matter, which defends the edge of the eye-lid from the acrid tears, and closes them more accurately by its unctuosity. The vascularity of the inner surface of the eye-lid is subservient to these glands; for the vessels forming their ramifications round the little glands, secrete the sebaceous matter into them. This, then, is the seat of the ophthalmia tarsi; and following this inflammation, the edges of the eye-lids, and the mouths of the ducts, are sometimes eroded with little ulcers. These ducts are the seat of the stye. This is an inflammation and closing up of the mouth of one of the ducts, which then swells up into a little hard granule in the edge of the eye-lid, accompanied with inflammation of its cyst or surrounding membrane.

OF THE SECRETION AND COURSE OF THE TEARS.

THE LACHRYMAL GLAND is seated in the upper and outer part of the orbit, and behind the superciliary ridge of the frontal bone. It is of a flattened form, and is depressed into a hollow of the bone. Several ducts from this gland open upon the inner surface of the upper eye-lid. By the reflection of the membrana conjunctiva from the eye-lid over the surface of the eye-ball, dust and motes are prevented from getting behind the eye-ball: and when they have got under the eye-lids, the extreme sensibility of the tunica conjunctiva excites the lachrymal gland, and the orbicular muscle of the eye-lids, (which, by its pressure, accelerates the flow of the tears,) and the dust or motes are washed out. The puncta for re-absorbing the tears and conveying them into the nose, being at the inner angle or canthus of the eye-lids, we see the intention of the ducts of the lachrymal gland opening on the inside of the upper eye-lid towards the outer angle: for, by this means, the tears are spread over all the surface of the eye-ball, by the motion of the eye-lids, before they decline into the puncta. But the tears do not flow only when the gland is excited by motes; their secretion is perpetual, and, together with the motion of the eye-lids, they

perpetually moisten the surface of the eye-ball. Even during sleep they flow continually: and here we may admire a provision for their conveyance towards the inner canthus, in the inclination of the tarsus to each other; for the eye-lids meet only on the outer edge of the broad surface formed by the tarsus, the consequence of which is, that a kind of gutter is formed in the angle by the inner edges of the tarsus not meeting, which leads the tears from the ducts of the lachrymal gland towards the puncta lachrymalia.

The PUNCTA LACHRYMALIA are the mouths of two ducts which form the beginning of a canal for drawing off the tears from the eye into the nose. These puncta are placed at the inner canthus of the eye, and on the termination of the tarsus of the upper and under eye-lid: they are surrounded by a rigid substance; and their patent mouths absorb by capillary attraction. They lead the tears into the lachrymal sac, and thence the tears pass into the nose.

The CARUNCULA LACHRYMALIS is that little granulating-like body which lies in the inner angle formed by the two eye-lids. Very small hairs are seen to sprout from it, and some small sebaceous follicles open upon its surface. Connected with the caruncula lachrymalis is the MEMBRANA OF VALVULA SEMILUNARIS. This is a vascular membrane which is drawn from under the caruncula lachrymalis by the direction of the eye outward, so as then to appear like a web spread over the white of the eye near the inner canthus. By directing the eye towards the nose, this membrane is again accumulated about the caruncula. This, then, is a very particular mechanism, not as is generally described, for applying the tears to the puncta lachrymalia, but for accumulating and throwing out the motes and dust from the eye, and for guarding the puncta from the absorption of such little particles as might irritate or obstruct them.

In birds, the valvula semilunaris is drawn, by a muscle and small tendon inserted into it, quite across the eye, so as to act like a third eye-lid; it is in them called membrana nictitans.

The LACHRYMAL SAC and DUCT lie in the os unguis or lachrymale. The sacculus is a bag of an oblong or oval figure; it is sunk into the fossa of the os unguis, and defended by the frontal process of the superior maxillary bone; and it is covered by the ligamentous connection of the orbicularis muscle.—This sac is the dilated upper end of the nasal duct; and into it the two canaliculi lachrymales (the extremities of which are the puncta,) open as distinct tubes.*

* Dr. Monro.

Two coats are described as covering the lachrymal sac; a nervous, white, external coat; and a vascular, pulpy, pituitary membrane. This sac diminishing towards the lower part, and being received into the complete canal of the bone, becomes the nasal duct. Taking a course downward and backward, it opens into the nose under the inferior spongy bone.—The lachrymal sac and duct are by some conceived to be muscular, so as to enable them to convey the tears into the nose; or it may be conceived, that they act like a syphon, the duct reaching down into the nose acting like the long leg of the syphon, and drawing the tears in at the openings of the puncta. But I think it would appear, that the connections of the orbicularis muscle over the sac is of a nature to accelerate the passage of the tears, and even perfectly to compress the sac. The lachrymal sac and duct are very frequently diseased and obstructed. For example, after small-pox, siphilis, or in scrophulous constitutions, the inner membrane of the sac being of the nature of the pituitary membrane of the nose, inflames, swells, and adheres. The consequences of this are, first, a swelling of the lachrymal sac in the inner angle of the eye, and a watery or weeping eye; upon pressing the tumour, the tears, mixed with mucus, are forced back through the puncta; bye and bye the sac inflames and suppurates; matter is discharged by pressure of the sac: and, lastly, it is eroded and bursts out, discharging the tears and matter on the cheek. This is the complete character of the fistula lachrymalis. While the sac bursts outwardly, it often does further mischief within, by making carious the thin lamina of bone in which it lies. The theory of the ancients, with regard to this disease, was that the disease was proceeding from the caries of the os unguis, and they perforated with the actual cautery, until the patient smelt it in the nose! as much with the intention of remedying the caries, as to give passage to the tears. But it is not the bone which is the obstruction to the perfect cure of this disease by operation, but the membranes, which close again after the most ingenious attempts to preserve the passage. The vis medicatrix, in this instance, seems not to be so well aware of her interest as some physiologists would inculcate. She is, here, ever at variance with the artifice of the surgeon.

BOOK II.

OF THE EAR.

CHAP. I.

OF SOUND, AND OF THE EAR IN GENERAL.

THE ear is that organ by which we are made susceptible of the impression of sound.

Sound is the motion of elastic fluids, occasioned, in general, by the vibration of solid bodies: and this vibration of the solids depends upon their elasticity or tension: or sound may be produced by the vibration and motion of the air primarily, but not without the intervention of solids. The human voice, for example, does not depend merely on the percussion of the air, but on that vibration, as combined with the tension and consequent vibration of the glottis, excited by the current of air; which, again, is modified by the mouth. In the same manner, the sound and variety of tone, in musical instruments, depends on the joint effect of the vibrations of the solids, and of the air.

There is no body impervious to sound, or, in other words, incapable of transmitting the vibration. That sound is communicated through the medium of the air, we know from the circumstance, that a bell, when struck in a vacuum, gives out no sound: and again, from this, that the condensed state of the atmosphere affords an easier communication of sound, and conveys it to a greater distance. The velocity of the impression transmitted by the common air, is computed at 1130 feet in a second; and sound, when obstructed in its direct motion,

is reflected with a velocity equal to that with which it strikes the solid body by which its progress is interrupted.

That water conveys the vibrations producing sound, has been proved by experiment. It was once the saying of naturalists, that, to suppose fishes to have the organ of hearing, would be to conceive that an organ were bestowed upon them without a possibility of its being of use. But we are assured of the fact, that, on the tinkling of a bell, fishes come to be fed;* and it was the custom for the fishermen on the coast of Britany, to force the fish into their nets by the beating of drums,† as our islanders are at present accustomed to do when the larger fish get entangled amongst the rocks. We are told, that, in China, they use a gong for the same purpose. These facts were once of importance, though more accurate observation has now made them superfluous. The Abbe Nollet took much pains to decide the question, whether water was a medium for sound. After considerable preparation, and acquiring a dexterous management of himself in the water, (for which he takes great merit to himself,) he found that he could hear under water the sound of the human voice, and even distinguish conversation and music. The human ear being an organ imperfectly adapted to this medium of sound, these experiments do not inform us of the relative powers of air and water in the transmission of sound. But another experiment of the Abbe Nollet proves, what indeed to me is sufficiently evident, from the structure of the ear of fishes, viz. that the water transmits a much stronger vibration than the air. When he sunk under water and struck together two stones which he held in his hands, it gave a shock to his ear which was insupportable, and which was felt on all the surface of his body, like that sensation which is produced when a solid body held in the teeth is struck by another solid body.‡ He observed in other experiments, that the more sonorous the bodies struck were, the less vivid was the impression; by which it would appear, that water, though it conveys an impression more strongly to the ear than the air, is not equally adapted to the resonance and variety of

* Boyle.

† M. l'Abbe Nollet, Acad. R. des Sciences. Naturalifts were very incredulous of the effect faid to be produced by mufic on lobfters. Some may be fo ftill; but we may truft the following obfervation of Minafius, in his Differtation. "*Su de timpanetti dell udito fcoperti nel Granchio Paguro.*" "Proprii obfervationibus certior factus afferit, obfcura nocte, placidoque mari, quoties pifcatores ardentibus facculis paguri in littore hærentis oculos lucis fulgore perftringunt, ut ftupido, et pene præftigiato animale potiantur, fi forte rumor aliquis ingruit. CANCRUM illico fe e littore fubducere recipereque intra undas." See *Scarpa Difquifitiones Anatomicæ* de Auditu in Infectis, &c.

‡ Thefe experiments were repeated by Dr. Monro. See his Book of Fifhes.

tone. Indeed, this is a natural consequence of the water, a fluid of greater density being in close contact with the sounding body, and suppressing its vibration. In these facts, we shall find the explanation of some peculiarities in the structure of the ears of fishes.

Thus, we see, that the vibration of a solid body is continued through the air and through water, until reaching the organ of hearing, it produces the sensation of sound. Sound, it will be evident, is also communicated through solids. When we put the ear to one end of a log of wood of thirty feet in length, and strike upon the other, we are sensible of the impression; and when a solid body applied to the bones of the head, or to the teeth, is struck, we are sensible of the noise;* and this is felt even by those who are deaf to impressions conveyed through the air: indeed it is partly in this way that we are to judge whether deafness may be cured by operation, as depending upon some injury of the mechanism of the organ, or whether it be an incurable affection of the nerve or brain itself. If the sound be perceptible when conveyed through the teeth, or when a watch, for example, is pressed upon the bone behind the outer ear, we are assured that the internal organ is unaffected; and upon enquiring farther into the case, we may find that the deafness proceeds from some disease of the outer tube of the ear, or of that tube which leads into the throat, and that it can be remedied.

CHAP. II.

GENERAL VIEW OF THE VARIETIES IN THE EARS OF ANIMALS†.

THERE is in the scale of animals a regular gradation in the perfection of the organ of hearing. But, in the human ear, we find united all the variety of apparatus for communicating

* Perhaps we cannot call this ſound.

† In the following ſhort account of the comparative anatomy of the ear, although I have taken every aſſiſtance in my power from books, I have deſcribed the ſtructure, in all the examples, from my own diſſections and obſervation.

the vibration to the internal organ, and along with this the most extensive distribution of nerves in the labyrinth, or inmost division of the ear, to receive that impression.

The ultimate cause of this more complex structure is the greater power with which man is endowed of receiving, through the ear, various impressions of simple sounds: language, music, and various modifications of the sense, of which the lower animals are incapable.

As, in treating of the anatomy of the eye, we do not attempt to investigate the manner in which light acts upon the retina, in producing the sensation of colours, but endeavour merely to explain the structure of the eye; to show how the coats support and nourish the humours; how the humours are subservient to the concentration of the rays of light, and assist their impulse upon the retina: so, in the same manner, in explaining the structure of the ear, we need not investigate the philosophy of sound, nor the nature of those impressions which are made by it on the sensorium through the nerves; our views are limited to the structure of the ear—we have to observe the mechanism by which the strength of vibrations is increased and conveyed inward to the seat of the sense, and the manner in which the nerve is expanded to receive so delicate an impression.

The method of studying this subject, which is at once the most instructive and the most amusing, is to trace the various gradations, in the perfection of the organ, through the several classes of animals. It is chiefly by comparing the structure of the viscera, and the organs of sense in animals and in man, that comparative anatomy is useful in elucidating the animal œconomy. For example, in the stigmata and air-vessels of insects and worms; in the gills of fishes; in the simple cellular structure of the lungs of amphibiæ; in the more complicated structure of the lungs of birds; we observe one essential requisite through the whole gradation, viz. the exposure of the circulating fluids to the action of the air. And in this variety of conformation, we see the same effect so modified as to correspond with the habits and necessities of the several classes of animals. In the same manner, with regard to the circulating system, we are taught the explanation of the double heart in the human body, by tracing the variety of structure through the several classes of animals; from the simple tube circulating the fluids of insects, the single ventricle of fishes and reptiles, the double auricle and perforated ventricle of amphibiæ, up to the perfect heart of the warm-blooded animal. The organs of generation, and the œconomy of the fœtus in utero, is, in the same degree, capable of illustration from comparative anato-

my. But most especially, in the structure of the ear, is there much scope for this kind of investigation. We find such varieties in the ear of reptiles, fishes, birds, and quadrupeds, as lead us, by gradual steps, from the simpler to the more complex structure.

The simplest form of the organ of hearing is that in which we find a little sac of fluid, and on the inside of the sac the pulp of a nerve expanded. If an animal, having such an organ, breathe the air, a membrane closes this sacculus on the fore part; and, by means of this membrane, the vibrations of the air are communicated to the expansion of the nerve through the fluid of the sac. But if the animal inhabits the water only, it has no such membrane to receive the impression; the organ is incased in bone or cartilage, and instead of the membrane, some small bone or hard concreted matter is found in contact with the pulp of the nerve. The sound, passing through the waters, is, in such case, conveyed to the organ not by any particular opening, but through the bones of the head; and this concrete substance, partaking of the tremulous motion, communicates the sensation to the nerve*.

For example, in the CRAB and LOBSTER, we find a prominent bony papilla or shell, which is perforated with a membrane extended across the perforation, and behind this membrane there is a fluid, in which the nerve is expanded, and which receives the impulse conveyed to the membrane. In the CUTTLE-FISH, again, there is no external opening; there is merely a little sac under the thick integuments: this sac has in it a small concretion or bone for receiving the vibration; which, in this animal, is conveyed by a more general impression upon the head than in those last mentioned; and the vibration of this loosely poised bone or concrete seems equal to the provision of the membrane which, in the crab, closes up the external opening in the perforated shell.

In FISHES, there is a considerable variety of structure. Those which remain perpetually under water, have not the outer membrane, nor any apparatus for strengthening the first-received undulations of sound. But such as lie basking on the surface of the water, and breathe through lungs, have an external opening—a canal leading to the membrane, and behind the membrane bones to convey the vibration to the internal parts, and these internal parts, the seat of the sense, are actually as perfect as in terrestrial animals.

* It is conceived by some that the antennæ of insects conveys to them the vibration of bodies, and that they may be considered as an imperfect variety of this organ.

In neither of the species of fishes, the cartilaginous nor spinous fishes, is there a proper external opening, as in animals breathing air. They receive the impulse from the water, upon the integuments and bones of the head; but within the head, and in the seat of the sense, they have a most beautiful apparatus for receiving and conveying those general vibrations to the expanded nerve. There is in every ear, adapted to hearing under water, a bone or concretion, placed so as to vacillate easily, and which is destined to agitate the fluid in which it is suspended with a stronger vibration than could be produced merely by a general impulse. Besides this provision in fishes, there is a very elegant structure for still further increasing the surface destined to receive the impulse, and for exposing to that impulse or vibration a larger proportion of the expanded nerve. It consists of three semicircular tubes, which penetrate widely within the bones of the head. They are filled with a fluid, and have in their extremities a division of the nerve which is moved or otherwise affected by the vibration of the fluids contained within the tubes.

There is a slight variety, however, in the ear of cartilaginous fishes. In the head of the SKATE, for example, there is under the skin, at the back of the head, a membrane extended across a pretty regular opening. This, however, is not considered as the opening of the ear; but a passage, like a mucous duct, which is beside it, has given occasion to a controversy between Professors Scarpa and Monro; and it may not be out of place to inquire a little into this disputed point.

We have seen that water conveys the sound of vibrating bodies with a shock almost intolerable to the ear, and with a particular and distinct sensation over the whole body. We see, also, that, in the greater number of fishes, there is confessedly no external opening, the whole organ is placed under the squamous bones of the head. Yet the cartilaginous fishes, which are supposed to have an external ear, swim in the same element, and are in no essential point peculiar in their habits. And we should receive with caution the account of any peculiarity in the organ of hearing of one class of fishes, which is not common to all inhabiting the same fluid. Such animals as occasionally pass from the water into the air, must have a membrane capable of vibrating in the air; but, even in them, it is expanded under the common integuments, and protected by them. Were it otherwise, when the creature plunged into the water, it would be assailed with that noise, (confounding all regular sounds), of which man is sensible when he plunges under water. It appears opposite to the general law of nature, to suppose any species of fish having that simple and more de-

licate membrane, which is evidently intended to convey atmospheric sounds only, while, on the other hand, creatures living in the water alone, should have an organization fit to endure the stronger vibrations of their denser fluid, and which would be useless and absurd in those existing in our atmosphere.

When we come to examine the ear of the skate, we find, that what Dr. Monro conceives to be the OUTWARD ear of the fish,* is really, as represented by Dr. Scarpa, a mucous duct merely ;† which does not lead into the sacculi of the vestibule and semicircular canals, as appeared to Dr. Monro ; and that to suppose this would be to acknowledge the free access of air and water to the immediate seat of the organ, and to the soft pulp of the auditory nerve, a thing absurd in every view, impossible in nature, and very wide of the truth.‡ To me, it appears, that this narrow duct cannot be considered as the external ear ; because we find in the skate a proper membrane under the thin integuments, quite unconnected with the duct, for transmitting the sound ; and, upon following this mucous duct, we find it taking a circuitous course, and filled with a strong gelatinous matter ; it is every where narrow, and filled with a glutinous secretion. It has no membrane stretched across it, and bears no resemblance to the external ear of any other animal.

We may conclude, then, that fishes have no external opening like terrestrial animals ; that, instead of this outward provision they have the moveable bone within the organ. Although the cartilaginous fishes have a membrane extended over part of the organ, which, in the spinous fishes, is completely surrounded with bone, it is not to be considered as capable of the tremulous motions of the membrana tympani of terrestrial animals, but may be considered as analogous to the membrana fenestræ ovalis : and, since it lies deep under the integuments, we have no reason to believe that sound is transmitted to the organ of

* "In the upper and back part of the head of a ſkate, and in a large fiſh weighing 150 pounds, at the diſtance nearly of one inch from the articulation of the head, with the firſt vertebra of the neck or atlas, two orifices, capable of admitting ſmall ſized ſtocking wires at the diſtance of about an inch and a quarter from each other, ſurrounded with a firm membranous ring, may be obſerved. Theſe are the beginnings of the Meatus Auditorii Externi." Treatiſe on the Ear, p. 208.

† Dr. Scarpa, ſpeaking of this opinion of Dr. Monro, ſays, "qua in re vehementer ſibi hallucinatus eſt, oſtia nimirum ductuum mucoſorum, ut manifeſtum eſt, pro auris meatubus accipiens. Etenim omnino nullum eſt in cartilagineis piſcibus oſtium auditus extus adapertum, membranaque *feneſtræ ovalis* ſub communi integumento recondita jacet et cooperta."

‡ "Quod et abſurdum eſt et a rei veritate quam maxime alienum." Vid. *Anatomicæ Diſquiſitiones de auditu et olfactu, auctore.* A. Scarpa.

hearing in fishes, any otherways than through the general vibration of the head.

The organ of hearing in amphibious animals, demonstrates to us a difference in the manner in which the sensation is received; for they have both the outer membrane to receive the vibration of the air, and a mechanism of small bones to convey this motion into the seat of the sense; and they have, besides, within the ear itself, a chalky concretion: a provision plainly intended for propagating the motion communicated through the water.

In serpents, birds, and quadrupeds, we shall hereafter trace the various gradations in the perfection of this organ. We shall find, that, as the animal rises in the scale, the cavities and tubes of the ear are extended and varied in their form. Now, I conceive that, while the multiplied forms of the tubes and sphericles of the internal ear afford a more expanded and susceptible surface for receiving impressions, the consonant forms of the parts enable them to receive a stronger vibration, and a more perfect and modified sound.

A cord of a musical instrument will vibrate when another in exact unison with it is struck. The vibration communicated to the air is such, as is adapted to the tension of the sympathetic cord; and no other percussion of the air, however violent, will cause it to sound. Again, the air passing through a tube of certain dimensions, will not communicate to it a motion, nor call forth its sound, while the air, passing in equal quantity through a tube of one degree of difference, will rise into a full note. What holds true in regard to the unison of cords, is also true of cylinders, or even of the walls of a passage or room, a certain note will cause the resonance of the passage or room, as a certain vibration will call forth the sound of the tube of an organ; because it is in all these instances necessary that the impulse be adapted to the position of the surfaces and their powers of reverberation. Sound, as allied to music, consists in the succession, the rhythm or time of its return upon the ear.

These few facts illustrate what I mean, by saying, that the various forms of the internal ear of animals, as they advance in the scale, give additional powers to their organ. In the first example of the simple ear, where a bone vibrates on the expanded nerve, I should conceive that the sensation were, in consequence of this simple percussion, capable of little variety; but in animals where, besides this simpler mechanism, there are semicircular canals, and more especially in those animals, which have still a further complication of the forms of the ear, certain sounds will be peculiarly felt in each of these several cavities and convolutions; and, while the sensation is becom-

ing more distinct, by the perfection of the organ, it admits, also, of a greater variety of sounds or notes : so that a certain state of vibration will affect the semicircular canals, (one or all of them,) and produce the sensation of sound, which would not at all affect the vibration of the simple lapilli lying in their sac.

CHAP. III.

DESCRIPTION OF THE ORGAN OF HEARING IN PARTICULAR ANIMALS.

IN THE LOBSTER AND CRAB.

IN these animals, the structure of the ear is very simple ; but it appears to me, that Professor Scarpa, in his description, has imagined the organ to be more simple than it is in nature.

In the LOBSTER, there projects from near the root of the great antenna, an osseous papilla of a peculiarly hard and friable nature. In the point of this papilla we observe a foramen, and a membrane stretched over it. This is the seat of the organ of hearing. It is described as containing a sac of a pellucid fluid, which adheres to the membrane, while the auditory nerve is expanded upon the lower surface of the sac. Now, the lobster, being an animal which can live on land as well as in water, Scarpa gives this as an instance of a structure calculated to receive the sensation of sound equally well from the water or from the atmosphere. But, from the figure I have given of the ear of this creature, it will not appear to be so exceedingly simple ; while there is evidently a provision for the reception of the vibration communicated through the water, though it does not indeed strictly resemble that which is commonly found in the ears of fishes. There is suspended behind

the sacculus, and in contact with the nerve, a small triangular bone, which, when pulled away,* is found to hinge upon a delicate cartilage. This bone seems evidently intended, by its being thus suspended in the neighbourhood of the PULP OF THE auditory nerve, for impressing upon that nerve the vibration from the water. The lobster, then, has, like the amphibious animals, a double provision for receiving the communication of sound alternately from the water or from the air.†

The ear of the CRAB differs from that of the lobster in this, that, under the projection, there is a moveable case of bone, to which we see a small antenna attached. Within this is the organ of hearing; and there is here an internal provision for the transmission of sound to the auditory nerve, which consists simply in a few circumgyrations of a pellucid and flexible cartilage: an inspissated fluid surrounds this gyrous cartilage, while the pale auditory nerve is expanded behind it.

OF THE EAR OF FISHES. In the heads of fishes, there is a cavity separated by a thin vascular membrane from that which contains the brain. Within this cavity there is a sacculus distended with a fluid, and containing a small bone;‡ on the inside of this bag, (which is called the sacculus lapillorum,) a great proportion of the auditory nerve is expanded. In the cartilaginous fishes, there are three lapilli§ contained in their proper capsules, and surrounded with a gelatinous matter,‖ each of the lapilli having its appropriated division of the acoustic or auditory nerve distributed upon it in a beautiful net-work.

This cavity in the head of fishes, resembles the centre of the labyrinth in the human ear, and is called the vestibule. Within the vestibule there is a limpid fluid, intersected every where by a delicate and transparent cellular membrane; and the parts within the vestibule are supported in their place by this tissue, which is similar to that which supports the brain in fishes.

Besides this central part of the organ in fishes, there are departing from the vestibule three semicircular cartilaginous canals,¶ within which, are extended membranous canals.— These membranous tubes contain a fluid distinct from that

* See fig. 2.

† From the mucous-like tranſparency of the nerve in the lobſter, it is difficult to aſcertain its exact relation to this bone.

‡ See plate, fig. 3.

§ In many of the ſpinous or ſquamous fiſhes, there is only one. In cartilaginous fiſhes, theſe bodies are not like bone, but like ſoft chalk. In the ſpinous fiſhes, on the other hand, they are of the ſhape of the head of a ſpear, and hard like ſtone.

‖ The gelatinous matter is rather before the bones, and diſtending the little ſacculi.

¶ See plate 7. fig. 3. and fig. 4. D D D.

contained in the common cavity of the vestibule, nor have they any communication with the sacculi, which contain the lapilli, although they are connected with them.* These cartilaginous canals are of a cylindrical form, and, being as transparent as the fluid with which they are surrounded, are not readily distinguished in dissection. Each of the cartilaginous canals is dilated at one of its extremities into a little belly, which is called the ampulla.

The auditory nerve in cartilaginous fishes† is first divided into two fasciculi, which are again subdivided into lesser nerves. These go to the three sacculi lapillorum, and to the ampullulæ of the semicircular canals. Before the division of the nerve peculiar to the sacculus pierces it, and is finally distributed, it forms a singular and intricate net-work of filaments. The branches to the ampullulæ are raised on a partition which is opposed to the mouth of the cylindrical part of the tube.

In the spinous fishes, the three semicircular canals unite in a common belly; but in cartilaginous fishes, the posterior semicircular canal is distinct from the others.

In fishes, all the parts of the ear are filled with a matter of a gelatinous consistence, or viscid fluidity; and the whole sacculi and semicircular canals are surrounded with fluid. That jelly is the most susceptible of vibration, is evident, when we fill a glass, and allow a body to fall into it; for then the delicate vibration is communicated to the finger on the outside of the glass, or, by striking the glass, we may observe the tremulous motion of the jelly. The semicircular canals, it is evident, are well adapted to receive the extensive vibrations communicated through the bones of the head, and to convey them inward to the nerve expanded in the ampulla.

From the simpler to the more perfect aquatic animals, we may trace several links of the chain by which nature advances towards the perfect structure of the ear. We return now to observe, in the first example of terrestrial animals, the most simple state of that part of the organ which receives the sensation; but where the structure of the receiving organ is the most simple, the mechanism for receiving the vibration and conveying it to the internal ear, is modified and adapted to the atmosphere.

OF THE EAR IN REPTILES AND AMPHIBIOUS ANIMALS.

In REPTILES, which form the intermediate class of animals

* So Professor Scarpa asserts, in contradiction to others.

† The fifth pair of nerves in fish answers to the seventh in man; it has the same division into the *portio mollis* and *dura*.

betwixt fishes and quadrupeds, the ear has also an intermediate structure; in some individuals of this class the ear resembles that of fishes, such as we have described, while, in others, it resembles more nearly the common structure of terrestrial animals.

In the salamandra aquatica, a variety of the lizard, there is a foramen ovale*, deep under the integuments. In this foramen there is a cartilage, in immediate contact with which, there is a common sacculus lying in the cavity or vestibule; and in this little sac there is found a cretaceous matter: there are here, also, semicircular canals, with ampullulæ, and a common belly connecting them. In this animal, then, it is evident, the ear is similar in structure to that of the cartilaginous fishes†.

In the FROG, the outward apparatus is different, but the internal ear is simple‡. Under the skin of the side of the head, a little behind the prominent eye, we find a large circular opening, which tends inward in a funnel-like form: and from the upper part of the circle of this meatus we find a small elastic bone, or cartilage suspended. This bone is in contact with the common integuments of the head, which are stretched over the little cavity. This first bone is placed at a right angle with a second bone, and both are lodged in a proper tympanum§. This second bone swells out towards its inner extremity, and is accurately applied to the foramen ovale. The foramen ovale opens into a cavity which we must call the vestibule, and which, in this creature, is peculiarly large in proportion to its size. This vestibule contains a sac, upon which the nerve is expanded: it contains also a chalky soft concretion, which is of a beautiful whiteness, and of a regular figure when first seen, but has no solidity‖. The vestibule here, as in all other animals, being the immediate seat of the sense, is filled with fluid.

In SERPENTS, the mechanism external to the seat of the organ is less complete than in the frog. From the scales behind the articulation of the bone which keeps the lower jaw

* This is the appropriated appellation of the opening which leads from the outer cavity of the ear, or tympanum, into the feat of the proper organ where the nerve is expanded.

† It is faid by naturalifts, that the falamander never has been heard to utter a cry; and as dumbnefs is in general coupled with deafnefs, it is natural to fuppofe it has no ears. This is to confider the organ as fubfervient to converfation!

‡ See plate, fig. 5 and 6.

§ This tympanum, being a cavity containing air, has communication with the mouth by a tube, which we fhall afterwards find called euftachian tube. Several have erroneoufly defcribed this animal as receiving founds through the mouth.

‖ See fig. 6. D.

extended, a little column of bone* stretches inward and forward. This bone has its inner extremity enlarged to an oval figure, and is inserted into the foramen ovale. This creature has no membrana tympani, nor does it appear to have so good a substitute as the frog: the outer extremity of the bone seems rather attached to the lower jaw by a cartilaginous appendage and small ligament†. Within the scull, serpents have the little sac, with the cretaceous matter and semicircular canals, united by a common belly‡.

In the TURTLE, we find a proper tympanum, and by lifting the scaly integuments from the side of the head a little above the articulation of the lower jaw, we open this cavity.—Through this cavity there extends a very long and slender bone, which, upon the outer extremity, is attached by a little elastic brush of fibres to the cartilaginous plate under the integuments, while the inner extremity is enlarged, so as to apply accurately to the foramen, which opens into the vestibule; and a passage also opens from the cavity of the tympanum into the fauces. In this animal, as in all which we have classed under the present division, the internal ear consists of a central cavity, or vestibule, which contains a sac with fluid, and cretaceous matter, and of three semicircular canals connected by a common belly. This common belly of the semicircular canals has no communication with the sacculus vestibuli which contains the cretaceous matter, further than as it lies in contact with it, and as they both lie surrounded by a fluid; they equally receive the impression of the little bony column, the extremity of which vibrates in the foramen ovale.

There being enumerated forty or more varieties of the LACERTA OR LIZARD, many of these have very different habits. Some of them never pass into the water, but inhabit dry and dusty places. The lacerta agilis, or common green lizard, which is a native both of Europe and of India, is nimble, and basks, during the hot weather, on the trunks of old trees and on dry banks; but on hearing a noise, it retreats quickly to its hole. It has the skin over the tympanum extremely thin, and such as to answer precisely the office of the membrane of the tympanum. So all the varieties of reptiles which, in their habits and delicacy of hearing, resemble terrestrial animals, have either the membrane of the tympanum or a skin so delicate as to produce the same effect; while those, which inhabit

* Plate, fig. 7. B.

† See Scarpa, tab. v. fig. ix.

‡ Serpents are affected by music; and they will raise and twist themselves with every variety of lively motion to the pipe and tabor.

the water, have a rough integument, or a hard scale, drawn over the tympanum. Besides this, some have a small muscle attached to the bone, which runs across the tympanum; it is like the tensor tympani, and is another step towards the proper structure of the terrestrial ear.

OF THE EAR IN BIRDS..

Comparing the internal ear of birds with that of those animals which we have already described, we find a very important addition. We find here the internal ear (or labyrinth, as we may now call it), consisting of three divisions: the vestibule, or middle cavity; the semicircular canals; and the cochlea; which last is an additional part, and one which we have not in the class of animals already described. Leading into these three cavities, there are two foramina: the FENESTRA ROTUNDA, and the FENESTRA OVALIS; and both these openings have a membrane stretched over them in the fresh state of the parts. The first, the fenestra ovalis, or foramen ovale, receives the ossiculus auditus, which is in birds like that which we have already described in reptiles*. This ossiculus connects the membrana tympani (which is here of a regular form) with the vestibule, and conveys the vibration of the atmosphere to it.

The semicircular canals are here also three in number, and are distinguished by the terms minor, major, and maximus; but as the major and minor coalesce at one of their extremities, and enter the vestibule together, the semicircular canals open into the vestibule by only five foramina in place of six. Each of the semicircular canals is dilated at one extremity into an elliptical form, while the other extremity is of the natural size of the diameter of the tube. These canals are formed of the hard shell of bone, and are surrounded with bone, having wider and more open cancelli.

In the dry state of the parts, we find a cord passing through the semicircular canals, which some have called the ZONULÆ NERVÆ. But these are the membranous canals, which are

* Mr. Home, in his lecture on the muscularity of the membrana tympani, (vid. Phil. Tranf. A. 1800), fays, in birds this membrane has no tenfor mufcle to vary its adjuftments, but is always kept tenfe by the preffure of the end of the flender bone. This is a very imperfect account of the mechanifm of the tympanum in birds. There are two bones, or one fmall bone with a cartilage, which lies along the membrana tympani. This elaftic cartilage has two little tendons attached to it. Even the flender bone which ftretches from the cartilage to the foramen ovale, the inner extremity of which is enlarged to fill up that hole feems to have a fmall tendon inferted into it; but whether this be a mufcular or ligamentous connection, I am unable at prefent to fay.

contained within the bony ones, dried and shrunk up. Within the bony cavities of the labyrinth, there is laid a pellucid membrane, which contains a fluid, has the nerves expanded upon it, and is the true vestibule and semicircular canals; while the bony case, which we have described, is merely the mould of these and the support of their delicate texture.*

The COCHLEA, one of the three divisions of the labyrinth, is but imperfect in birds, when compared with that part of the organ in quadrupeds and in man. The cochlea in birds consists merely of two cylinders, formed of cartilage, which are united toward their further extremity. While the opposite extremities diverge, and while one of these cylinders opens into the vestibule, the other opens outward into the cavity of the tympanum.†

That which more than any other circumstance distinguishes the organ of birds from that of animals inhabiting the waters, is the want of the bone or stony concretion in the sacculus vestibuli.

CHAP. IV.

OF THE HUMAN EAR.

THE anatomy of the human ear will naturally be considered under three heads: the external ear; the tympanum; and the labyrinth. The OUTWARD EAR requires no definition.— From the outward ear there is a cartilaginous tube, which leads into the tympanum. The TYMPANUM is the cavity within

* I lately, by accident, drew out the ſacculus veſtibuli and ſemicular canals from the bony part of the ear of a bird, and I found the membranous ſemicircular canal to conſiſt apparently of the ſame pellucid elaſtic matter with thoſe of fiſhes.

† We find Mr. Home ſaying that the cochlea is neither abſolutely neceſſary to fit the organ to be impreſſed by ſounds communicated through the air, nor to render it what is termed a muſical ear; and that this is ſufficiently proved by that part being wanting in birds, whoſe organ is particularly adapted to inarticulate ſounds. That the cochlea is not neceſſary to the communication of ſound through the atmoſphere, we have ſeen from the examination of the ear of the reptile. But ſince we ſee that it forms part of the labyrinth in birds, we may be led to doubt Mr. Home's concluſion.

which is placed that mechanism of bones and muscles which increases the strength of the vibration, and conveys it inwards to the labyrinth. The LABYRINTH is the general name of those intricate canals which contain the expanded nerve, and the immediate seat of the organ.

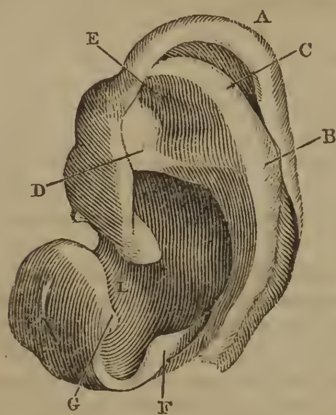
SECTION I.

OF THE EXTERNAL EAR.

The EXTERNAL EAR is formed of an elastic cartilage, covered with very thin integuments. The apparently irregular surfaces of the outer ear will be found, upon examination, to be so formed that the sinuosities lead gradually into each other, and finally terminate in the concha or immediate opening of the tube of the ear. By the constant motion of the external ear of quadrupeds, we see its importance to them, both in collecting sound, and in judging of its direction. In most men, the motion of the ear is lost, but some men still retain it; and this is very remarkable, that when the more internal mechanism of the ear is injured, and ceases to strengthen the sound before it conveys it inwards to the labyrinth, the external ear resumes the office to which it was originally adapted, and by a degree of motion and erection, assists the hearing. In Europeans, the outward ear is in a great degree flattened to the head by the dress; but in Eastern nations, and in ancient statues, we see the ears stand prominent, and bear a part in the symmetry and expression of the whole head. The muscles moving the cartilages, besides being intended to give motion, appear to have a more essential use in giving a due tension to the outward ear. These cartilages are surrounded with their peculiar perichondrium; but as to their vessels and nerves, it seems very superfluous to give a minute description of them here.

When the cartilages are dissected, they appear thus :

Fig. 18.



A. The HELIX. It is the outer margin, the edge of which is turned over and forms the cavitas innominata.

B C D. The ANTHELIX. It is very prominent ; of a triangular shape ; and within the outer rim or margin.

E. The SCAPHA, which is a depression or cavity on the anterior part of the anthelix.

F. The TRAGUS.

G. The ANTITRAGUS. These are the two prominent points which approach each other, and form the margin of the great cavity of the ear.

L. The CONCHA, or great cavity of the ear, and which is the trumpet-like opening of the meatus auditorius externus. The few pale-coloured fibres which are found on the cartilages, are scarcely to be recognized as muscles.*

The LOBE of the ear, or that part which hangs down and is pierced for the ear-ring in women and savages, consists of skin and cellular substance merely.

The MEATUS AUDITORIUS EXTERNUS, is the tube which leads into the tympanum. This tube is partly bony and partly cartilaginous. The outer portion of the tube is cartilaginous, and about three quarters of an inch in length, and is divided by fissures. The internal part of the tube is formed in the bone,

* See Valfalva & Santorini.

as we find upon turning to the description of the temporal bone.

Glands of the passage. The cuticle, covering the inside of the tube, is very fine, and there project from it many small hairs which stand across the passage. Under this skin there is a set of small glands, which pour their secretion into the tube, and are called the GLANDULÆ CERUMENOSÆ.* These glands, secreting the wax of the ear, have their little ducts opening betwixt the roots of the hairs; and this secretion, with the hairs which stand across the passage, guards the internal parts of the ear from insects. The whole passage, consisting of the long canal of the temporal bone and the cartilaginous tube placed upon it, has an oblique direction. It first passes upward and forward, and then makes a slight curve to descend to the membrane of the tympanum.

This external tube of the ear, being of the nature of a secreting surface, and exposed to the air, is liable to inflammation. There follows a dryness of the passages, and then a more fluid secretion. If the inflammation of the tube should extend within the bones, then, like the affections of all parts surrounded with solid bone, the pain is extreme and the danger considerable: there is not only suppuration in the tympanum and destruction of the membrana tympani, but the disease may be still further communicated internally. Hildanus gives us an observation of the effects of a ball of glass dropt by accident into the ear, in which the inflammation was so extensive, and the pain so excruciating, that the whole side of the head and even the arms and leg of that side were affected, in consequence of the brain partaking of the inflammation. Such things as peas and cherry-stones and pins are very apt to be put into the ear by children; and awkward attempts to extract the foreign body, very often push it further in; and acrid fluids put into the ear to kill insects, have forced them deeper, with such an increase of pain as has thrown the patient into a condition little short of delirium. A defective or too profuse secretion from the glands of the tube, will cause a degree of deafness: and sometimes the wax is so indurated as to cause a very obstinate deafness.†

* "Hæ figuram obtinent variam: major tamen harum pars vel ad ovalem, vel ad ſphæricam accedit colore tinguntur flavo ab humore in earum folliculis contento qui ob aſſiduam fibrarum carnearum reticularium preſſionem, per cutis correſpondentia foramina in meatus auditorii cavitatem tranſmittitur." Valſalva de aure humana, p. 10.

† See Valſalva, p. 10. "Talis funditalis a duodecim annis affligentis curatio." The older writers treat of the "Auditus læſio a ſordibus aurium lapideſcentibus." See *Bonetus*, & Jul. *Caſſertus Placantinus*, "*De auditus organo*," *lib* 1. *cap*. 20. *p*. 90. There is alſo mention made of an adventitious membrane, cloſing up the paſſage

In the fœtus, the concha and meatus externus are narrow, and there is secreted a thick white stuff, which defends the membrane of the tympanum from the contact of the waters of the amnios. This, after birth, falls out in pieces along with the secretion of the wax; but, in some instances, it has remained and become very hard. The deafness from birth, caused by this accident, is often thought to depend upon an organic defect, and so is neglected.

SECTION II.

OF THE TYMPANUM OR MIDDLE CAVITY OF THE EAR, AND ITS DISEASES.

THE ANATOMY OF THE TYMPANUM.

In the fœtus, the cavity of the tympanum is superficial, compared with that of the adult; for what forms a tube in the latter, is in the former merely a ring, which is attached to the squamous portion of the temporal bone:* upon this circular bone the membrane of the tympanum is extended.

The cavity of the tympanum is very irregular; intermediate betwixt the membrane which is extended across the bottom of the external tube and the labyrinth or internal ear. It contains no fluid, as the labyrinth does; but is really a cavity, having a communication with the external air through a tube which leads into the fauces. The tympanum communicates also backwards with the cells of the mastoid process.† The inner extremity of the meatus externus forms a circle which is pretty

and ſtretched above the membrana tympani. This is produced by a foul ſecretion, and reſembles that which ſtuffs up the paſſage in the fœtus. See Fabricius de Chirurg. operat. cap. de aur. Chirurg. Veslingius Anat. cap. 16. See Experiments on the ſolvents of the Ear-wax, by Dr. Haygarth, Med. Obſ. and Inquiries, vol. iv. p. 198. He gives the preference to warm water over every other ſolvent.

* See plate 8. fig. 3.

† When Valſalva, in a caſe of ulceration and caries on the maſtoid proceſs, threw in his injections, he found them flowing out by the mouth: viz. by the euſtachean tube through the tympanum. See Val. de aure humana, p. 89.

regular, and upon which the membrane of the tympanum is extended. That part of the cavity of the tympanum which is opposite to the termination of the meatus externus, is very irregular. It has in it the foramen rotundum and the foramen ovale; and betwixt these, there is an irregular bony tuberosity from which there stretch back some exceedingly small spiculæ of bone, which connect themselves with the margin of the irregular cavity of the mastoid process.

The FORAMEN OVALE* is in the bottom of a deep sinus; it is not strictly of an oval form, but has its lower side straight, while the upper margin has the oval curve. This opening leads into the vestibule or central cavity of the labyrinth.

The FORAMEN ROTUNDUM is more irregular than the oval hole. It does not look directly forward, like it, but enters on the side of an irregular projection: it does not lead into the vestibule, but into one of the scalæ of the cochlea. In the recent state of the parts, the periosteum covering the surface of the cavity of the tympanum, takes away much of its irregularity. Where the tympanum leads backward into the CELLULÆ MASTOIDEA, this periosteum is also continued.

THE EUSTACHEAN TUBE † extends forward from the cavity of the tympanum, and opens behind the palate.‡ In the dry bones, the eustachean tube is more like an accidental fissure, than a regular passage, essential to the œconomy of the ear. It appears thus irregular in the bones from the tube being towards the back of the nose, composed of membrane and and cartilage; as the tube approaches the opening behind the palate, it widens into a trumpet shape; and the soft extremity of the tube is governed by muscular fibres.

There can be no doubt that the eustachean tube is designed for admitting the free access of air into the cavity of the tympanum, that, by preserving a due balance betwixt the atmosphere and the air contained within the ear, the motion of the membrane of the tympanum may be free. This, at least, we know, that, when the extremity of the eustachean tube is closed, we suffer a temporary deafness, which can be accounted for only by the confined air wanting a due degree of elasticity to allow the vibration of the membrane of the tympanum. I conceive it to be necessary, that the air in the tympanum be changed occasionally, which is, perhaps, accomplished by some actions of the throat and fauces forcing a new body of air into the eustachean tube. The extremity of the eustachean

* Fenestra ovalis.

† Iter a palato ad aurem.

‡ By some older writers, the eustachean tube is called aqueduct, because they conceived that tumours were evacuated from the tympanum by this passage.

tube, next to the throat, may be temporarily obstructed by the cynanche tonsillaris, which is frequently attended with pain, stretching from the throat to the ear; or it may be closed by inflammation and adhesion of its mouth, by adhesion of the soft palate to the back of the fauces, by polypus in the nose, reaching down into the fauces and compressing it*.

OF THE MEMBRANA TYMPANI.

The membrane of the tympanum is extended over the circular opening of the bottom of the meatus externus. It has a little of an oval shape, and lies over somewhat obliquely, so that its lower margin is further inward than the upper. Its use is, to convey the vibrations or oscillation of the atmosphere, collected by the outer ear, inwards to the chain of bones in the tympanum. Although this membrane be tense, it is not stretched uniformly like the parchment of a drum, but is drawn into a funnel-like shape by the adhesion of the long process of the malleus to its centre. It consists of two layers of membrane, and has, naturally, no perforation in it; and the experiments of air and the smoke of tobacco sent from the mouth through the ear, succeed only in those who have had the membrane of the tympanum partially ruptured or eroded by ulceration. This membrane is transparent; and when we look into the tube of the ear, and direct a strong light into it, we observe it to be of a shining tendinous appearance.

The inner lamina of the membrana tympani is very vascular. It has, indeed, been said, to resemble the iris, both in its profusion of vessels, and in the manner of their distribution†. This is carrying the conceit of their analogy too far. I have observed an artery of a very large size, (compared with the surface to be supplied), running by the side of the long process or handle of the malleus. In this course, it is giving out small branches; and when the trunk arrives at the extreme point of the long process of the malleus, it divides into two considerable branches, the extreme subdivisions of which run towards the margin of the membrane. This artery is, nevertheless, too small to require us particularly to avoid it in the

* The following caſe is from Valſalva:—"Quidam plebeius ulcus gerebat ſupra uvulam in ſiniſtra parte, quod quidem eam, quam invaſerat, partem exeſerat atque abſtulerat ſic, ut ulceris cavitas cum extremo ſiniſtræ tubæ orificio communicaret. Igitur quoties homo mollem turundam remediis imbutam in ulceris cavitatem intrudebat; toties illico ſiniſtra aure evadebat ſurdus, taliſque permanebat toto ex tempore quo turunda in ulcere relinquebatur:" p. 90.

† See Mr. Home's lecture on the ſtructure and uſe of the membrana tympani. Phil. Tranſact. Part I. 1800.

puncturing of the membrane for deafness, produced by obstruction of the eustachean tube.

The opinions regarding the muscularity of the membrane of the tympanum, shall be reserved until we have considered the whole mechanism of the parts in the tympanum.

OF THE CHAIN OF BONES IN THE TYMPANUM.

The vibrations of the membrane of the tympanum are transmitted to the foramen ovale by four moveable bones; the malleus, incus, os orbiculare, and stapes. These bones are named from their shape, and the names assist in conveying an idea of their form. They are so united by articulation and small ligaments, as to form an uninterrupted chain; and, while they transmit the vibration, their mechanism is such, that they strengthen the impulse. They have also small muscles attached to them, by which it is probable, the whole apparatus has a power of adapting the degree of tension to the force of the impulse communicated to the membrane of the tympanum. I conceive that they increase the power of the ear for receiving the weaker sounds, and are, at the same time, a guard to the internal parts, from such violent shocks as might injure the nerve.

How necessary it sometimes is to damp and suffocate, in some degree, piercing sounds, we must all be sensible: and in those who are habitually exposed to the sudden eruption of sound, the susceptibility of the nerve is injured, and they become very deaf. We have, in a late publication, an example of this in blacksmiths, in whom, it is common to find a degree of deafness; and we frequently find old artillery-men quite deaf, from the long practice of their profession.

The malleus* receives its name from a resemblance to a hammer or mallet: it is, in some degree, like a bludgeon; the great head stands obliquely off from the body of the bone, (if such it may be called), like the head of the thigh-bone.— Anatomists can scarcely be blamed, if, in describing the processes of this bone, they forget the body. I should consider that part as the body of the bone which stretches down from the circular margin of the tympanum, and is attached to the membrane, or what we should consider as the handle of the mallet. This part of the bone stands at an angle with the head and neck; tapers towards the extremity, and is a little curved down towards the membrane. From the larger end of the body of the bone there stands out an acute process; and

* See plate 9. fig. 1. A.

from the neck attaching the bulbous head to the body of the bone, there stands out a very slender process, which is often broken off. The great head of the bone does not form a regular ball to be socketed in the body of the incus ; there are irregularities in the contiguous surfaces of both the bones.

THE INCUS* is the second bone of the chain : it receives its name from its resemblance to the blacksmiths anvil. It more resembles a tooth with two roots. On the surface of the body, it has a depression like the surface of the first molaris. Into this depression of the incus the head of the malleus is received. The shorter of the two processes, and the body of the bone lie on the margin of the circular opening of the tympanum ; and the acute point of this process is turned back into the opening of the mastoid cells. The long leg or process of the incus hangs down free into the tympanum,† and has attached to its point the os orbiculare.

The OS ORBICULARE is like a grain of sand, and is the smallest bone of the body : it is a medium of articulation betwixt the incus and stapes.

THE STAPES‡ or stirrup is well named, for it has a very close resemblance to a stirrup-iron ; the little head is articulated with the os orbiculare : the arch of the bone is exactly like that of the stirrup-iron, but elegantly grooved within, so as to give lightness to the bone. The base answering to that part of the stirrup-iron upon which the foot rests, is not perforated, nor is it of a regular form, but is flat on one side, corresponding with the foramen ovale. It is this base of the bone which is attached to the membrane stretched over the foramen ovale.

CONNECTION AND MOTION OF THESE BONES.

The malleus hanging on that part which we have called the neck of the bone, has the long handle or body of the bone stretched down upon the membrane of the tympanum. It is, consequently, destined to receive the oscillations of that membrane.

The head of the malleus is so articulated with the incus, that the degree of motion communicated to that bone is much increased.

* See plate 9. fig. 1. B.
† See plate 4. fig. 1. D.
‡ See plate 9. fig. 1. C.

From this scheme, we see, that the head of the malleus is so articulated with the body of the incus, that the centre of motion of the incus is in a line drawn through the centre of its body, and, consequently, that the extremity of the long process, to which we see the os orbiculare and stapes attached, moves through a greater space than that which receives the impulse of the head of the malleus. Thus, a very small degree of motion communicated by the head of the malleus to the body of the incus, must be greatly increased in the extremity of the long process of the incus, and, consequently, this mechanism of the bones essentially assists in giving strength to the vibration which is transmitted inward to the seat of the nerve.

The os orbiculare stands simply as a link of communication betwixt the extremity of the incus and the upper part of the stapes, and its use is evidently to promote the accurate and perpendicular motion of this long lever of the incus upon the head of the stapes: for, if this bone had not been so placed, the motion of the long lever of the incus must have given an obliquity to the impulse upon the stapes. The base of the stapes almost completely fills up the foramen ovale. It is seated on a membrane which is stretched over the foramen.* The stapes, then, acts like a piston on a membrane of much less circumference than that of the membrana tympani. From all which considerations, we may learn how much, and how strongly, the agitation of the air in the outer canal of the ear is increased, before it strikes upon the fluids of the labyrinth.

* Valſalva has the following obſervation; ſee page 24. "Olim namque in cujuſdam ſurdi cadavere ſurditatis cauſam in eo ſitam inveni nempe quod indicata membrana in ſubſtantiam offeam indurata, unum continuatum os conſtituebat cum baſi ſtapedis et margine feneſtræ ovalis."

OF THE MUSCLES WITHIN THE TYMPANUM.†

The laxator tympani runs in a fissure of the temporal bone on the outside of the eustachean tube, and is inserted into the long process of the malleus. THE TENSOR TYMPANI‡ runs also by the side of the eustachean tube; it is inserted into the body of the malleus; it is a long and slender muscle. The external or superior§ muscle of the malleus, which is denied by some anatomists to be of the nature of muscle, comes down from the upper part of the tympanum, and is fixed by a small tendon to the neck of the malleus.

THE STAPEDIUS|| is the smallest muscle, and is attached to the smallest bone. It has a small round fleshy belly, taking its origin from the rough side of the tympanum, and is inserted by a small round tendon into the head of the stapes.

As all these muscles are inserted either into the malleus or stapes, and not into the middle bone, it would appear that their operation is chiefly upon the membranes of the tympanum, and of the foramen ovale, through the medium of the bone immediately attached to them.

Mr. Home, in the Philosophical Transactions for 1800, asserts, that the membrana tympani is muscular; that its fibres run from the circumference towards the centre; and that they are attached to the malleus.

But, what is the supposed use of this muscular membrane? Mr. Home says, it is principally by means of this muscle that accurate perceptions of sound are communicated to the internal organ; that it is by means of this muscle that the membrana tympani is enabled to vary its degree of tension, so as to receive the vibrations in the quick succession in which they are conveyed to it. But we have seen, that the tension and relaxation of the membrana tympani is already sufficiently provided; for "the malleus has three muscles by which it is moved; one of them is called the tensor, from its pulling the malleus inward and tightening the membrane of the tympanum; the other two act in an opposite direction, and relax the membrane."* We should naturally suppose this to be sufficient; but, according to Mr. Home, these muscles act only to bring the membrane into such a degree of tension, as to enable the minuter

† Mufculus proceffus minimi mallei. Valfalva.
‡ Mufculus proceffus majoris mallei.
§ Mufculus proceffus minoris. Valfalva.
|| This mufcle is particularly ftrong in the horfe, where it was firft difcovered by Cafferius.
* Mr. Home's Lecture.

changes of the muscular membrane to have their full effect; and that the play of these muscles gives the perception of grave and acute tones.

But the more favourite idea of Mr. Home is, that, upon the accurate adjustment of the membrana tympani, the difference between a musical ear, and one which is too imperfect to distinguish the different notes in music, depends; that this judgment or taste is owing to the greater or less degree of nicety with which the muscles of the malleus render the muscular membrane capable of being truly adjusted; if the tension be perfect, all the vibrations produced by the action of the radiated muscle will be equally correct, and the ear truly musical.

Mr. Home proceeds upon the idea, that the membrane of the tympanum is like a musical instrument, or, as he expresses himself, like a monochord; but he is fundamentally wrong in supposing, that it requires a more delicate organ to be perceptible of musical tones than of articulate sounds or language.

In the first place, we may require an explanation of the use of that muscle which is inserted into the stapes. This stapedius muscle would seem to have the same use, and to affect that bone in the same manner, in which the muscles of the malleus affect it. Surely Mr. Home will not go so far as to say, that the membrana fenestræ ovalis is also muscular. It may be further worthy of attention, in considering this subject, that whatever affects the membrane of the tympanum, affects, also, the membrane of the vestibule; that, if the one be relaxed, the other is rendered tense, from the close connection that exists between them through the chain of bones.

In the paper already quoted, the following case is given, as illustrating the manner in which the loss of the natural action of the muscles affects the ear, in regard to its capacity for music. A gentleman, thirty-three years of age, who possessed a very correct ear, so as to be capable of singing in concert, though he had never learned music, was suddenly seized with a giddiness in the head, and a slight degree of numbness in the right side and arm. These feelings went off in a few hours, but on the third day returned; and for several weeks he had returns of the same sensations. It was soon discovered that he had lost his musical ear; he could neither sing a note in tune, nor in the smallest degree perceive harmony in the performance of others. For some time, he himself thought he had become a little deaf, but his medical attendant was not sensible of this in conversation. Upon going into the country, he derived great benefit from exercise and sea-bathing.

In this case, continues Mr. Home, there appeared to be some affection of the brain, which had diminished the action

of the tensor muscles of the membrana tympani, through the medium of the nerve which regulates their actions; this gradually went off, and they recovered their action.

Another case is given of a young lady who was seized with a phrenzy which lasted several years, when, from being without a musical ear, she came to sing with tolerable correctness, to the astonishment of her friends.

Now, to me, the symptoms of both cases argue an affection of the brain, and of the nerves. It is more probable that the delicate auditory nerve should be affected in such a disease, than that the portio dura should alone be affected.

We now proceed to put the incorrectness of this reasoning concerning the muscular power of the membrane of the tympanum, in a more particular point of view. Mr. Cooper was led to pay particular attention to the action of the membrane of the tympanum, from being consulted in a case where the membrane was lost with little injury to the function of the organ*. He found, that, instead of the total annihilation of the powers of the organ, the gentleman was capable of hearing whatever was said in company, although the membrane of both ears was destroyed. He could even hear better in the ear in which no traces of the membrane remained. This gentleman was only in a small degree deaf from the loss of the membrane; but his ear remained nicely susceptible of musical tones, "for he played well on the flute, and had frequently borne a part in a concert; and he sung with much taste, and perfectly in tune." This case puts aside, at once, that theory

* Cafe. This gentleman had been attacked at the age of ten years, with an inflammation and fuppuration in his left ear, which continued difcharging matter for feveral weeks: in the fpace of about twelve months after the firft attack, fymptoms of a fimilar kind took place in the right ear, from which matter iffued for a confiderable time. The difcharge, in each inftance, was thin, and extremely offenfive to the fmell; and in the matter, bones, or pieces of bones, were obfervable. The immediate confequence of thefe attacks was a total deafnefs, which continued for three months; the hearing then began to return; and, in about ten months from the laft attack, was reftored to the ftate in which it at prefent remains. Having filled his mouth with air, he clofed the noftrils, and contracted the cheeks; the air thus compreffed, was heard to rufh through the meatus auditorius with a whiftling noife, and the hair hanging from the temples became agitated by the current of air which iffued from the ear. When a candle was applied, the flame was agitated in a fimilar manner.

Mr. Cooper then paffed a probe into each ear, and he thought the membrane on the left fide was entirely deftroyed, fince the probe ftruck againft the petrous portion of the temporal bone. The fpace ufually occupied by the membrana tympani, was found to be an aperture without one trace of membrane remaining. On the right fide, alfo, a probe could be paffed into the cavity of the tympanum; but here, by conducting it along the fides of the meatus, fome remains of the circumference of the membrane could be difcovered, with a circular opening in the centre, about the fourth of an inch in diameter. See Trans. Roy. Soc. for 1800, Part I. p. 151.

which supposes the musical ear to depend on the minute play of the muscles of the tympanum.

It appears, then, that the membrane of the tympanum may be destroyed, that the bones may be washed out by matter formed in the tympanum, and still the patient retain the use of the organ. But this is only while the stapes retains its place; for, if this bone be also destroyed, the membrane of the foramen ovale will be destroyed, and the fluids of the labyrinth be allowed to flow out, or be otherwise lost. We see, that, if the chain of bones, and only a part of the membrana tympani be left, still this shred of membrane, if it be not detached from the handle of the malleus, will vibrate in the air, and communicate those vibrations through the other bones to the vestibule. We see, also, that though the bones only remain, and though they be detached from the membrane of the tympanum, the sound will still be communicated. We see, that a rupture of the membrane will not destroy the organization so far as to prevent the hearing, unless there follow clots of blood or inflammation, suppuration, or fungus. When Mr. Cooper found that the membrana tympani could be torn without injuring the organ, he did not stop short in his investigation: but as he found, by daily experience, that obstruction of the eustachean tube caused deafness, he thought of puncturing the membrana tympani, as a cure for that kind of deafness. He expected, by this operation, to give elasticity to the confined air. Accordingly, by puncturing the membrane of the tympanum with a small trocar, he found, with much satisfaction, that the hearing was instantly restored*.

Valsalva made a good distinction, when he said, that the membrane of the tympanum was not absolutely necessary to hearing, but only, to perfect hearing. We have, in this fact, the explanation of the following circumstance, amongst many others: "In naturali surditate a conformationis vitio inter tandum istud experimentum, (viz. an ossiculi et membrana tympani aliquis sit usus auditum), quod inopinato et feliciter successit cuidam, qui intruso auri scalpio in aurem profundissime disrupit tympanum, fregitque ossicula et audivit." *Biolanus Encherid. Anat. lib.* 4. *c.* 4. See also *Bonetus de Aurium Affect. Observ.* IV. Willis also knew, that the destruction of the membrana tympani did not deprive the person of hearing. *Vid. de Anima Brutorum.*

* I am only afraid that ſuch punctures will not continue open, as in Valſalva's experiments they healed up very ſoon. But, when there is no other ingreſs and eſcape to the air in the tympanum, but through the punctured hole, it may tend to keep it open.

§ 2. OF THE DISEASES OF THE TYMPANUM.

Valsalva denied the existence of periosteum to these bones of the tympanum, while he allowed that they had minute vessels distributed on their surfaces: but these vessels he supposed to creep along the naked bone independently of any membrane. This, however, is contrary to all analogy. These bones, as well as the cavity of the tympanum, are covered with a very fine membrane or periosteum, which, after a minute injection, is seen covered with many small and distinct vessels, as well as with intermediate extravascular effusions of the injection, as happens in injecting in other membranes.

When the tympanum becomes diseased, there is fetid matter collected, the membrane of the tympanum suffers, and the small bones are sometimes discharged. In such a case, we have little farther to do than, by injections, to prevent the matter from accumulating. But, let us not confound this serious cause of deafness with the slighter suppurations in the outer passage of the tube: although such suppurations in the tube of the ear are apt, when neglected, to destroy the membrane of the drum or tympanum, and to spread disease to these internal parts.

Authors make a display of the diseases of the membrane of the tympanum under the titles relaxatio, tensio, nimia, induratio, and diruptio tympani*. We have seen how little rupture of the membrane affects the hearing, and may thence conclude, that these fantastic imaginings about tension and relaxation of the membrane deserve little notice. The idea of relaxation of the membrane of the tympanum, I have no doubt, has arisen from the effect of cold and moist weather in injuring the hearing; but deafness from this cause is not produced by relaxation of the membrane of the tympanum, but by swelling of the mouth of the eustachean tube†.

Induration of the membrane is less of an imaginary disease, since there are instances of the membrane becoming thickened by inflammation, or cartilaginous, or osseous. The membrana tympani has been found to adhere to the extremity of the

* See Du Verney de Organo Auditus, p. 41.

† " Relaxatio fit ab humore ſuperfluo qui membranam hanc humectat et ſymptoma hoc communiter cum obſtructione meatus ex tumore glandularum conjunctum eſt, de qua jam ſupra dictum eſt: multum autem facit ad difficultatem audiendi in perſonis quæ defluxionibus catarrhoſis obnoxiæ ſunt et per eandem raticnem auſtri nebulæ et aer pluvius auditum minuunt ut experiri quotidie poſſumus." Du Verney loc. cit. p. 41.

incus.* Independently of the want of elasticity, which such an adhesion must produce, the mechanical effects, the vibration of the bones, is prevented, and a degree of deafness is inevitable.

Fungous or polypous excrescences from the glands in the outer passage of the ear, press back and destroy the membrane of the tympanum. In the cure of these by the knife, caustic, or ligature, there is much danger of injuring the membrane.—Fungous tumours project from the membrane itself. A stroke upon the head will cause bleeding from the ear. This is often a sign of concussion of the brain; that is to say, a shock so severe as to rupture the membrane of the tympanum, will most probably injure the brain,† after bleeding from the ear. Sometimes suppuration follows;‡ and blood flowing thus from the membrane of the tympanum, or other part of the ear, runs back into the cavity of the tympanum, and, filling it with coagulum, causes deafness, by obstructing the free motion of the bones and membrane. Mr. Cooper, in a case of this kind, punctured the membrane, and, after a discharge of blood which continued for ten days, the hearing was gradually restored.—It is supposed by that gentleman, that the blood effused becomes, in some instances, organized, so as to obliterate the tympanum causing permanent deafness. I think it is more likely that the blood has, in such cases, destroyed the mechanism by suppuration.

The danger in suppuration and caries of the tympanum is, that the disease may penetrate backward into the mastoid cells and labyrinth, or into the brain itself; for inflammation and suppuration so confined amongst the deep recesses of the bone, must give great torture, and be apt to extend the mischief to the brain, or throw out matter on the inside of the cranium, the effect of which must be mortal. Such, I think, I have seen to be nearly the effect of suppuration deep in the ear. In a man who had been deaf for many years, and who was killed by a fracture of the skull, I found the cells of the temporal bones filled with matter, and a thin greenish fluid lay betwixt the temporal bone and dura mater.

Valsalva gives us a case of injury of the head, in which the patient was relieved while the discharge of pus by the ear was free; but he died when it was intirely suppressed.§

* See the London Philosophical Transactions for 1800, Part I. p. 5.

† When Valsalva found the ventricles of the brain full of blood, and blood also in the tympanum, he supposed that the blood in the latter was derived from the brain through certain foramina which he discovered. See p. 30.

‡ See Valsalva, p. 16.

§ Valsalva, p. 83. See also a case in Bonetus de Aurium Affect. Observ. I. and

But, after such suppuration as we should naturally think must totally destroy so delicate an organization, we are sometimes agreeably surprised with a gradual recovery of the function. This is owing to the nerve accommodating itself, or becoming sensible to a less forcible impression, and by the ear acquiring new properties. I already mentioned, that the destruction of the mechanism of the tympanum arose sometimes from suppurations beginning in the outward ear: and we may suppose that the apparatus within the tympanum, when partially hurt, is sometimes capable of being, in some degree, replaced by a natural process; of which, the following case from Valsalva is a remarkable proof.

"I lately examined the ears of a woman whose hearing had been much injured by an ulcer of the tympanum and caries of the small bone. I found the ear in which she was deaf without a membrana tympani, and the stapes only remaining of the bones, and a fibrous mass, like an excrescence, in the tympanum. But, in the tympanum of the opposite ear, I found the membrana tympani almost entirely eroded; so that the malleus and incus were uncovered, and distinctly seen. I could even observe, that the long process of the incus, which should be articulated with the head of the stapes, was separated from it: but nature had curiously restored the eroded membrane.— Thus, from the edge of the injured membrane, a new membrana tympani was obliquely stretched across the cavity of the tympanum, so as to exclude the malleus and incus from that cavity, but including the head of the stapes, as if nature, finding the separated bones no longer necessary, had attached the membrane to the head of the stapes.* We have already remarked, that, when the organ of one side is injured, we hear so much better with the other, that we attend only to the sensation conveyed by it, and neglect the duller sensation.— The consequence of this is, that the bad ear becomes worse. It is much like that effect which takes place in eyes by squinting.

Gul. Ballonius Epid. et Ephem. lib. 2. p. 270. When the matter was ſuppreſſed, there came pain of the head, and weight, which yielded to no remedy, on diſſection, there was found an abſceſs within the ſkull. In Bonetus loc. cit. a caſe is related, in which an ignorant ſurgeon compreſſed a fiſtulous ulcer in the ear, and ſo cauſed the death of the patient.

* See Valſalva de Aure Humana Tract. p. 79. In thoſe deaf from birth, it has been twice found that the *incus* was wanting. *See Bonetus de Aur. Affect. Obſerv.* IV.

SECTION III.

OF THE LABYRINTH.

The labyrinth is the internal ear; the proper seat of the sense of hearing. It consists of the vestibule or middle cavity; of the semicircular canals; and of the cochlea. It has its name from those cavities and tubes leading into each other in so intricate a manner, as to be followed out with much difficulty.

We understand that the cavities hitherto described in the human ear contain air, and communicate with the atmosphere: but, in the cavities we have now to describe, the nerve is expanded, and there is, in contact with it, not air, but an aqueous fluid. In treating of this division of our subject, we have, first, to attend to the forms of the cavities, as seen when sections are made in the dry bones next to the soft parts contained in those cavities; and, finally, to the distribution of the nerves. To give an idea of the exquisitely delicate and complex structure of the many canals, excavations, openings, sulci and foveæ, of the bones; of the tubuli, sacculi, and partitions of the membranes; and, lastly, of the soft expansions of the nerves, without the assistance of plates, would be impossible. Albinus, in his academical annotations, begins very formally a chapter on the ear; but, after a few words, dismisses the subject, referring merely to his plates.

THE VESTIBULE, or central cavity of the labyrinth, is of an oval form, and about a line and a half in diameter.* It has two remarkable pits or hollows in it, and has numerous foramina opening from it into the neighbouring cavities, besides lesser foramina for transmitting that portion of the nerve which is distributed on the sacs contained in it. One depression or fovea is in the back and lower part of the vestibule, another in the outer and superior part of it: the one is circular, the other semi-oval. Morgagni, and other anatomists, examining the dry bones, speculated on their use in reverberating the sound in the cavity; but we must not regard them in this unnatural state: on the contrary, they contain in the living subjects membranous sacculi filled with fluid, and have the nerve expanded upon them. That foramen over which the stapes is placed, and which is called the foramen ovale, transmits the vibration into the vestibule. For the foramen ovale opens directly into the vestibule, and through the vestibule, only, does

* Du Verney Œuvres Anatomiques.

the vibration of the bones in the tympanum reach the other parts of the labyrinth.

SEMICIRCULAR-CANALS. When we have cut into the vestibule, by taking away that portion of the os petrosum which is behind the meatus auditorius internus, we see five circular foramina: these are the openings of the semicircular canals.—There are three semicircular canals; and they are distinguished by the terms, the superior or vertical, the posterior or oblique, and the exterior or horizontal. The one which, in this view, is nearest, is the opening common to the inner ends of the posterior and superior semicircular canals. When we pass a bristle into this common foramen, and direct it upward, it passes along the superior semicircular canal, and will be seen to descend from the upper part or roof of the vestibule, almost perpendicularly on the foramen ovale, which is open, and immediately opposite. If, again, we pass a bristle into the foramen which is near the bottom of the cavity, (and which will be just upon the edge of the fracture that has laid open the vestibule, if not included in it,) it will come out by the opening common to the superior and posterior semicircular canal. It has passed, then, along the posterior canal. The two openings of the exterior or horizontal canal are upon the back part of the vestibule; and the canal itself takes a circle which brings its convexity to the confines of the mastoid cells. These canals are formed of a very hard brittle bone, their calibre is so small as not to admit the head of a common pin; they form somewhat more than a half circle; and of each of them, one of the extremities is enlarged like the ampullula of fishes. Valsalva imagined that the enlarged extremities of these tubes were trumpet-like, to concentrate and strengthen weak sounds.—We shall find, on the contrary, that there is in the human ear, as in fishes, a particular expansion of the nerve in these extremities of the tube, opposed to the circulatory vibration of the fluids in the canals.

THE COCHLEA. The third division of the labyrinth is the cochlea. It is so named from its resemblance to the shell of a snail, or from the manner in which its spiral lamina turn round a centre like a hanging stair. It has been minutely, but not simply, described: and, indeed, there can be nothing more difficult, than to describe it in words.

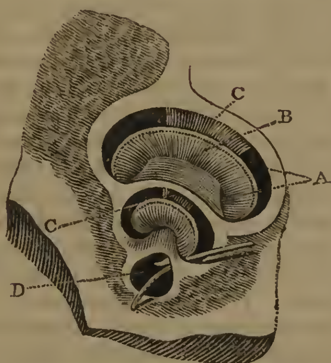
When the os petrosum is cut from around the cochlea, it is seen to be of a pyramidal shape, and to consist of a scroll, making large circles at the base, and gradually lesser ones towards the apex. It is formed in the most anterior part of the petrous bone, and has its apex turned a little downward and

outward; and the base is opposed to the great cul de sac of the internal meatus auditorius.

The spiral tube, of which the cochlea is composed, forms two turns and a half from the basis to the point; and it consists of the same hard and brittle matter with the semicircular canals. When the whole cochlea is cut perpendicularly in the dry state of the bones, and when the membranes have shrunk away or spoiled, the sides of the spiral canal appear like partitions, and are, indeed, generally described as such. In consequence of the spiral tube of the cochlea having its sides cut perpendicularly, the cochlea appears as if divided into three circular compartments or successive stages; but there is really no such division; because the spiral turnings of the tube lead from the one into the other.

Fig. 19.

Cochlea.



A. *Scalæ.*——B. *Lamina Spiralis.*
C. C. *Modiolus.*—D. *Infundibulum.*

What gives particular intricacy to the structure of this part of the labyrinth, is the LAMINA SPIRALIS. This spiral partition runs in the spiral tube of the cochlea, so as to divide it in its whole length; and, in the fresh state of the parts, this lamina of bone is eked out by membrane, so as to form two perfectly distinct tubes. These tubes are the SCALÆ COCHLEÆ; they run into each other at the apex of the cochlea; but at the base, the one turns into the vestibule, and the other opens into the tympanum by the FORAMEN ROTUNDUM.

In the middle of the cochlea there runs down a pillar, which is the centre of the circumvolutions of the scalæ. It is called the MODIOLUS. This pillar is of a spongy structure; and through it the nerves are transmitted to the lamina spiralis, and sides of the cochlea.

The modiolus opens towards the apex of the cochlea like a funnel; and when we take away the outward shell of the apex of the cochlea, which is called the CUPOLA, we look into this expansion of the upper part of the modiolus as into a funnel; it is therefore called the INFUNDIBULUM. The infundibulum is that part which, in a perpendicular section, we should call the upper partition.*

The scalæ or divisions of the spiral tube of the cochlea, have a communication at their smaller extremities in the infundibulum; and as, again, their larger extremities do not open into the same cavity, but one into the vestibule, and the other into the tympanum, the vibrating motion, which is communicated through the cochlea, must pass either from the tympanum into the foramen rotundum, circulate round the modiolus by the scala tympani, pass into the lesser extremity of the scala vestibuli in the infundibulum, and circulate through it towards the base of the cochlea, until it pass into the vestibule; or it must pass from the scala vestibuli into the scala tympani. The first is the opinion of Scarpa and others. But I trust it will afterwards appear, that the oscillations of sound are in the first place conveyed into the vestibule, and thence circulate round both the semicircular canals and cochlea.

In the dry bones, when we cut into the cochlea, there appears a spiral tube, as I have described; with a partition running along it, and, of course, taking the same spiral turns with it towards the apex. This is the bony part of the lamina spiralis; but, as the membrane which extends from its circular edge quite across the spiral tube of the cochlea, has shrunk and fallen away in the dry state of the parts, the lamina spiralis is like a hanging stair, and the scalæ are not divided into distinct passages. In this bare state of the shell of the cochlea, when we cut away the cupola or apex of the cochlea, and look down upon the infundibulum, we see the extreme point of the lamina spiralis rising in an acute hook-like point.

The modiolus or central pillar, and the lamina spiralis which encircles it, are of the most exquisite and delicate structure; for, through them the portion of the seventh nerve destined to the cochlea is conveyed. To say that the modiolus is formed of two central bones, is saying that there is no central column

* That is suppofing the cochlea to reft on its bafe.

at all; or, that the modiolus is the cavity seen in the bottom of the meatus auditorius: and to affirm, at the same time, that the modiolus is a nucleus, axis, or central pillar, is a contradiction in terms.

When we break away the shell of the cochlea, and break off, also, the spiral lamina, we find the little funnel-like depression in the bottom of the meatus internus reaching but a little way up into the centre of the cochlea.—We find this depression of the meatus auditorius internus perforated with innumerable small holes; and these foramina are so placed as to trace a spiral line, because they give passage to the nerves going to the spiral lamina, and must take the form of the diminishing gyrations of the lamina spiralis. In the centre of these lesser foramina, which are seen in the bottom of the great foramen auditorium internum, there is a hole of comparatively a large size, which passes up through the middle of the pillar. The modiolus is formed of a loose spongy texture, and resembles the turns of a cork-screw; and this spiral direction is a necessary consequence of the lamina spiralis, being a continuation of the spongy or cribriform texture of the modiolus.

INTERNAL PERIOSTEUM OF THE LABYRINTH. We find that the vestibule, the semicircular canal, and cochlea, besides their soft contents, which we have yet to describe, have their proper periosteum, which, after a minute injection, appears vascular; and this, as it has appeared to me, is particularly the case with the last mentioned division of the labyrinth. I see very considerable vessels distributed on the vestibule; particularly, I see their minute ramifications on the circular fovea, while very considerable branches are seen to course along the semicircular canals. In the cochlea, I see distinct branches of vessels rising from the root of the lamina spiralis, and arching on the scalæ, to the number of ten in the circle; and, after a more minute injection, I have found the osseous part of the lamina spiralis tinged red, and the membranous part of a deep scarlet*.

We have observed the MEATUS AUDITORIUS INTERNUS to be a large oval foramen in the posterior surface of the pars petrosa of the temporal bone. This tube transmits the seventh or auditory nerve. It is about five lines in diameter, but increases as it passes inward; and appears to terminate in two deep fovea, which are divided by an acute spine. But the auditory foramen only appears to terminate in these fovea, for they are

* In a preparation before me, I see a considerable artery derived from the basilar artery, and entering the meatus auditorius internus. From this trunk, I conceive that most of these arteries which I have described, are derived.

each perforated by lesser holes, which lead into the three divisions of the labyrinth, whilst a larger one conveys a portion of the nerve through the cavities of the temporal bone altogether, and out upon the side of the face. This larger foramen is in the upper part of the superior and lesser fovea. It first ascends to near the surface of the petrous part of the temporal bone*, and then descends and turns backward and takes a course round the tympanum above the foramen ovale; and close by the posterior semicircular canal. Its termination is the foramen stylo mastoideum†. Where this canal of the portio dura advances towards the surface of the pars petrosa, it is joined by a very small canal which extends from the videan hole on the fore part of the inclining face of the bone: again, after it has passed the tympanum, it is joined by a short canal which receives the corda tympani, after it has passed the tympanum.

The other foramen which is in the upper and lesser fovea of the meatus internus, is rather a cribriform plate, as it is a deep pit with many foramina in it. These lead into the vestibule, and form the MACULA CRIBROSA VESTIBULI‡. In the inferior and larger fovea, we observe several dark spots, which, when more narrowly examined, are also distinguished to be cribriform plates, or collections of lesser foramina. We particularly observe that conical cavity which is perforated with many little pores for transmitting the nerve into the cochlea, and which we have already mentioned. From the form which these foramina take, this is named the TRACTUS SPIRALIS FORAMINOLOSUS. These foramina, after passing along the modiolus cochleæ, turn at right angles, and pass betwixt the plates of the lamina spiralis.

Besides the tractus spiralis foraminolosus, the bottom of the larger fovea has many irregular foramina, which are like cancelli: for very delicate speculæ of bone stand across some of them. There is a range of these foramina which stretches from the tractus spiralis. This may properly be called the TRACTUS CALTHRATUS RECTUS§; they do not lead into the vestibule, but into the beginning of the lamina spiralis, where it divides the two scalæ cochleæ, and turns the orifice of one of them, (by a beautiful curve), out into the tympanum.

Nearer to the ridge which divides the two foveæ of the meatus internus, there is a little pit which has also a cribriform plate (like that which is in the upper fovea, and is called ma-

* In the fœtus, it becomes here superficial.
† This is the aqueduct of Fallopius.
‡ See Scarpa, Plate VII., fig. i, m.
§ Tractus spiralis foraminulosi initium. Scarpa.

cula cribrosa); opposite to this point, the inside of the vestibule is rough and spongy: it transmits a portion of the nerve to the sacculus in the hemispherical sinus of the vestibule*.

OF THE SOFT PARTS CONTAINED IN THE LABYRINTH.

Within the vestibule, semicircular canals, and cochlea, there are soft membranes independent of the periosteum. These form sacculi and tubes which contain a fluid, and have the extreme branches of the portio mollis distributed among them. Betwixt the soft and organized sacculi and tubes, and the periosteum of the osseous labyrinth, a watery fluid is exuded.

SACCULUS VESTIBULI. The hemispherical and semi-elliptical foveæ which we have described in the vestibule, contain, or at least receive partially, two sacculi. The sacculus which is in the hemispherical cavity, receives the most convex part of the sacculus vestibuli. This sac is distended with a fluid, and is pellucid, and fills the greater part of the vestibule; for only a part of it is received into the fovea. It forms a complete sac, and has no communication with the other soft parts of the labyrinth, though lying in contact with the alveus communis, presently to be mentioned; and being surrounded with an aqueous fluid, it must receive the impressions of sound in common with them.

ALVEUS COMMUNIS DUCTUUM SEMICIRCULARUM. This sacculus lies in the semi-elliptical fovea of the vestibule, or, like the other sacculus, is in part received into it. This sacculus receives the extremities of the tubuli membranacei which lie in the semicircular canals; it is a little bag common to them, and connecting them altogether, as in fishes: it is filled with fluid, and is so pellucid, as to be distinguished with much difficulty†. Upon pressing the common sac, or the ampullulæ of the semicircular canals, the fluids are seen to circulate along the membranous tubes of the canals. These two sacculi in the vestibule lie together, and firmly adhere, but do not communicate; yet, (as may be easily imagined), they cannot be separated without tearing the partition.

TUBULI MEMBRANACII. The tubuli membranacii are the semicircular tubes which pass along the osseous semicircular canals, and to which the latter are subservient, merely as supporting them. They are connected by means of the common

* Scarpa.

† Proprio humore turgidus adeo tranflucet ut ablongum bullulam aèream mentiatur. Scarpa, p. 47.

alveus in the vestibule, and form a distinct division of the organ.

It was believed by anatomists formerly, that the osseous canals had the pulp of the nerve expanded on their periosteum. But we find, on the contrary, that the membranous tubuli do not touch the bones, but are connected with them by a transparent cellular membrane-like mucus. Each of the semicircular membranous tubes has one extremity swelled out into an ampulla of an oval form, answering to the dilated extremity of those osseous tubes which we have already described.—These ampullæ have the same structure and use with those formerly mentioned in describing the ear in fishes. When the central belly of these tubes is punctured, both the ampullæ and the membranous canals fall flaccid.

Besides those vessels which we have described running along the periosteum of the cavities of the labyrinth, vessels also play upon the sacculi and membranous tubes. The ampullæ of the tubes are, in a particular manner, supplied with blood-vessels.*

In the COCHLEA there is also a pulpy membrane, independent of the periosteum ; but of this I can say nothing from my own dissection.

SECTION IV.

OF THE NERVE.

As the seventh pair of nerves arises in several fasciculi, they form what would be a flat nerve, were it not twisted into a cylindrical form, adapted to the foramen auditorium internum. While these fasciculi are wrapped in one common coat, they are matted together. In the canal, the nerve is divided nearly into two equal parts ;† to the cochlea and to the vestibulum and semicircular canals. Those fasciculi, which are destined for the vestibule, are the most conspicuous ; and on the portion

* "Caeterum univerfum hoc canaliculorum membraneorum alveique communis machinamentum. fanguiferis vafis inftruitur, quorum craffiora, circum alveum communem, ferpentino inceffu, ludunt ; crebra et conferta alia *ampullæ* imprimis recipiunt ob quam caufam rubellæ plerumque funt et cruore veluti fuffufæ."----Scarpa, p. 47.

† Of the portio dura we have already fpoken.

destined for the ampullæ of the superior and external canal, there is formed a kind of knot or ganglion.

Before the auditory nerves pass through the minute foramina in the bottom of the meatus auditorius, they lay aside their coats and become more tender and of a purer white colour; and, by being still further subdivided by the minute branching and divisions of the foramina, they cannot be followed, but finally expand in a white pulpy-like substance on the sacs and ampullæ. We must, however, recollect that there was a difference to be observed in the apparent texture of these expanded nerves in the lower animals: we may observe here, also, that part of the nerve which is expanded on the common belly or sacculus tubulorum, is spread like a fan upon the outer surface of the sac, and has a beautiful fibrous texture; but upon the inside of the sac, upon which it is finally distributed, it loses the fibrous appearance. We must suppose its final distribution to be in filaments so extremely minute, that we may call it a pulp; though by the term it must not be understood that an unorganized matter is meant.

That part of the nerve which stretches to the ampullæ, immediately divides into an opaque white mucous-like expansion. Beyond these ampullæ, there has been no expansion of the nerve discovered in the membranous tubes.

The sacculus vestibuli* is supplied by a portion of the nerve which perforates the macula foraminulosa in the centre of the osseous excavation, or that which receives into it part of the sac. This part of the nerve is expanded in a soft mucus-like white matter in the bottom and sides of the sac.

A division of the nerve, as we have already explained, passes from the meatus auditorius internus through the cribriform base of the modiolus into the cochlea. Owing to the circular or spiral form of the foramina when the nerve is drawn out from the meatus, its extremity appears as if it had taken the impression of these foramina from the extremities of the torn nerves preserving the same circular form. These nerves, passing along the modiolus and scalæ cochleæ, are in their course subdivided to great minuteness. Part of them perforate the sides of the modiolus, whilst others pass along betwixt the two plates of the lamina spiralis, and out by the minute holes in the plates and from betwixt their edges. Lastly, a central filament passes up through the centre of the modiolus, and rises through a cribriform part into the infundibulum to supply the infundibulum and cupola.

* i. e. In oppofition to the facculus tubulorum.

Where the nerves pass along the lamina spiralis, their delicate fibres are matted together into a net-work. According to the observations of Dr. Monro, they are quite transparent on their extremities.

CHAP. V.

OF HEARING IN GENERAL.

WHEN aërial undulations were, by the experiments on the air pump, first proved to be the cause of sounds, philosophers looked no further to the structure of the ear than to discover an apparatus adapted to the reception of such vibrations.—When they observed the structure of the membrane of the tympanum, and its admirable capacity for receiving these motions of the atmosphere, they were satisfied, without considering the immediate objects of sensation. In the same way, an ignorant person, at this day, would rest satisfied with the fact that sound was received upon the drum of the ear. But after so minutely explaining the anatomy of the ear, it becomes us to take a general survey of a structure the most beautiful which the mind can contemplate. We cannot say that it surpasses in beauty the structure of other parts of the body: but the parts are adapted to each other, in a manner so simple, efficient, and perfect, that we can better understand and appreciate the harmony of their structure than that of organs, which perform their functions by qualities and actions almost entirely unintelligible to us.

We see that the external ear collects the vibrations of sound as it moves in the atmosphere with circular undulation from the sonorous body: here we may observe, that where the necessities of animals require them to be better provided with this external part of the organ than man, the superiority is only in the simple perception of sound; while man, from the perfection of the internal organ, excels all animals in the capacity of the ear for articulate and musical sounds.

From the external ear we observe, that the trumpet-like tube conveys the sound inward to the membrane of the tympanum.

Behind the membrane of the tympanum, there is a cavity which, in order to allow of the free vibration of the membrane, contains air.—When this air is pent up, by the swelling or adhesion of the eustachean tube, the elasticity of the air is diminished, and the membrane prevented from vibrating.*

In the tympanum, we have seen that the operation of the chain of bones is to increase the vibration received upon the membrane of the tympanum, and to transmit it to the membrane of the foramen ovale. In the cavity of the tympanum we observed two foramina, the foramen ovale and the foramen rotundum, both of which lead into the labyrinth; but one of them (the foramen ovale) into the vestibule, the other (the foramen rotundum) into the scala of the cochlea: now it becomes a question, whether the oscillations of sound pass by one or by both of these foramina?

It is the opinion of many, that while the chain of bones receives the motion of the membrane of the tympanum, the motion of this membrane at the same time causes a vibration of the air in the tympanum which reaches the foramen rotundum, and thus conveys a double motion through the cochlea.

In the labyrinth there is no air, but only an aqueous fluid: now this, we have seen, conveys a stronger impulse than the atmosphere; stronger in proportion to its greater specific gravity and want of elasticity; for an elastic fluid like air may be compressed by concussion, but an inelastic fluid must transmit fairly every degree of motion it receives. But if the fluid of the labyrinth be surrounded on all sides; if, as is really the case, there can be no free space in the labyrinth, it can partake of no motion, and is ill suited to receive the oscillations of sound. Against this perfect inertia of the fluids of the labyrinth I conceive the FORAMEN ROTUNDUM to be a provision. It has a membrane spread over it, similar to that which closes the foramen ovale. As the foramen ovale receives the vibrations from the bones of the tympanum, they circulate through the intricate windings of the labyrinth, and are again transmitted to the air in the tympanum by the foramen rotundum. Without such an opening there could be no circulation of the vibration in the labyrinth; no motion of the fluids communicated through the contiguous sacculi, nor through the scalæ of the cochlea; because there would be an absolute and uniform resistance to the motion of the fluids.—But, as it is, the provision is beautiful. The membrane of the foramen rotundum alone gives way of all the surfaces within the labyrinth, and this

* See *Recherches*, &c. *relatives a l'organe de l'ouie & a la propagation des sons*, par M. Perolle, Societ. R. de Medecine, tom. iii.

leads the course of the undulations of the fluid in the labyrinth in a certain unchangeable direction.

To me it appears, that to give a double direction to the motion of the fluids, or to the vibration in the labyrinth, far from increasing the effect, would tend to annihilate the vibrations of both foramina by antagonizing them. The common idea is, that there is a motion communicated through the membrane of the foramen rotundum along the scala tympani, and another through the foramen ovale into the vestibule, and through the vestibule into the scala vestibuli; and that the concussion of these meet in the infundibulum of the cochlea. But as there is no space for motion in the fluids in either the one or other of these tracts, the vibration must have been received in the infundibulum at the same time that the motion was communicated to the membranes of the foramen ovale and rotundum; for if a tube full of water, a mile in length, loses one drop from the extremity, there must be an instantaneous motion through the whole to supply its place. The evident consequence of this double motion would be, (if they were of the same strength) to suppress all motion or vibration in the fluids of the labyrinth.

But we have shown that the strength of vibration communicated to the foramen ovale and foramen rotundum are not the same: for the mechanism of the bones in the tympanum is such as to accumulate a greater force or extent of motion on the membrana ovalis, than is received upon the membrana tympani; therefore the greater vibration which is communicated through the medium of the air in the tympanum, cannot be supposed capable of opposing the stronger vibration which circulates from the foramen ovale through the labyrinth, and returns by the foramen rotundum. Besides, the air in the tympanum has a free egress, and cannot therefore strike the membrane on the foramen rotundum forcibly.

For these several reasons, I conceive that the following account of the manner in which the sound is conveyed is erroneous:—" Et quo ad zonam cochleæ spiralem quoniam altera cochleæ scala in vestibulo patet, altera a FENESTRA ROTUNDA initium sumit, atque earum utraque aqua labyrinthi repleta est, et scalæ in apice cochleæ simul communicant, zona spiralis inter duas veluti undas sonoras media, a tremoribus per vasim stapedis, simulque ab iis per membranam *fenestræ rotundæ* advectis utraque in facie percellitur et una cum percillis acoustici nervi per eam distributis contremiscit: quibus porro omnibus, in ampullis videlicet canaliculorum semicircularium, alveo eorum communi, sacculo vestibuli spherico

et lamina cochleæ spirali acoustici nervi affectionibus auditum contineri nemo non intelligit*."

As to the immediate seat of the sense of hearing, there cannot, after what has been explained regarding the distribution of the nerves, remain any controversy; though before the structure of the ear was so well understood, some imagined that the vestibule, others that the middle part of the semicircular canals, was the seat of hearing; others, again, that the lamina spiralis was better adapted for receiving the vibrations of sound. It is evident that the soft expansion of the nerve, in all the three divisions of the labyrinth, is destined to receive the undulation of the contained fluids, and that this motion of the fluids gives to the nerve, or to the nerve and brain conjointly, the sensation of hearing.

Since we have, in some measure, traced the structure of the ear from the animals of a simple structure to those of a more complicated organization, and have observed some parts of the ear common to all animals, some peculiar to certain orders; and since all have the sense of hearing, more or less acute, it becomes natural to inquire what are the parts of the organ the most essential to the mere perception of sound, and what parts conduce to a more perfect state of the sense.

All the external apparatus of the ear is not necessary to give the animal the simple perception of sound. There are many classes of animals altogether without them, and even in man we see that they are not absolutely necessary; since when deprived of them by disease, man still enjoys the sense. He is deprived of no essential variety of the sensation; he is capable of perceiving the distinctions of articulate sound; and still possesses his musical ear. The external apparatus of the ear, the membrane of the tympanum, the little bones, and even the external ear, only receive, concentrate, and increase the tremors of the external air, and render the slighter impressions audible.

It would appear, that the simple sac of the vestibule is sufficient to receive the impression in some animals, and that in many the vestibule and semicircular canals form solely the organ of hearing. It is evident, therefore, that these are the most essential parts. We see also an intention in the strict similarity of figure and place in these canals through all the varieties of animals, from fishes to man. It would seem to indicate, that there is in their form and position a peculiar provision for the oscillation of sound producing the full effect.

We find, however, that the cochlea is imperfect in birds;

* Scarpa, p. 61.

and that it is fully formed only in man, and in quadrupeds: we must, therefore, conclude, that it is subservient to the more exquisite sensations. I do not conceive that the cochlea or any part of the organ particularly conduces to the bestowing of a musical ear, although it is by hearing that we are capable of the perceptions of melody and harmony, and of all the charms of music; yet it would seem, that this depends upon the mind, and is not an operation confined to the organ. It is enjoyed in a very different degree by those whose simple faculty of hearing is equally perfect*.

Even after studying, with all diligence, the anatomical structure of the ear, we cannot but be astonished with the varieties to be found in the sensation; for example:—"The ear is capable of perceiving four or five hundred variations of tone in sound, and probably as many different degrees of strength; by combining these, we have above twenty thousand simple sounds that differ either in tone or strength, supposing every tone to be perfect. But it is to be observed, that to make a perfect tone, a great many undulations of elastic air are required, which must all be of equal duration and extent, and follow one another with perfect regularity; and each undulation must be made up of the advance and recoil of innumerable particles of elastic air, whose motions are all uniform in direction, force, and time. Hence we may easily conceive a prodigious variety in the same tone, arising from irregularities of it occasioned by constitution, figure, situation, or manner of striking the sonorous body; from the constitution of the elastic medium, or its being disturbed by other motions; and from the constitution of the ear itself upon which the impression is made. A flute, a violin, a hautboy, a French horn, may all sound the same tone, and be easily distinguishable. Nay, if twenty human voices sound the same note, and with equal strength, there will still be some difference. The same voice, while it retains its proper distinctions, may yet be varied many ways: by sickness or health, youth or age, leanness or fatness, good or bad humour. The same words, spoken by foreigners and natives, nay by different provinces of the same nation, may be distinguished†."

That this variety of sensation does not entirely depend upon the structure, but is the operation of the sense and intellect conjointly, appears from the long experience which is requisite to give this perfection. Nature is bountiful in providing the means of simple and acquired perception, but the latter is the

* See Reid's Enquiry.
† Reid's Enquiry, p. 98.

result of long experience and continued effort, though we have lost the feeling of its being originally a voluntary effort.

CHAP. VI.

OF THE DISEASES OF THE INTERNAL EAR.

OF all the causes of deafness, that which proceeds from an organic disease of the brain is, of course, the most dangerous. In apoplectic affections, with faltering of speech and blindness, deafness is also produced by the general affection of the brain. But worst of all is the case where a tumor of the brain, or betwixt the cerebrum and cerebellum, compresses the origin of the nerves*. I have, however, observed, that a tumor in the *vicinity* of the origin of the auditory nerve, though it ran its course so as to prove fatal, had rather a contrary effect on the organ of hearing; and while the pupil of the eye remained stationary, and the man saw indistinctly, he had a morbid acuteness of hearing. This had probably been produced by the surrounding inflammation having extended to the origins of the auditory nerves. The auditory nerve often becomes morbidly sensible, and the patient suffers by the acuteness of perception, or is distressed with the tinnitus aurium, which is, in this case, analogous to the flashes of light which sometimes affect the eye in total darkness, and which those experience who are totally blind or have cataract. So morbidly acute does the sensation sometimes become, that the slightest motion of the head will excite a sensation like the ringing of a great bell close to the ear†. With delirium, vertigo, epilepsy,

* Vidit Clariff. Dom. Drelincurtius Tumorem fteatomatis confiftentia pugnique magnitudine, cerebrum et cerebellum inter, eo præcisè loco ubi conarium utrique fubfteritur choroidis plexus alæ, fpatio femeftri a fenfibili læfione, cæcitatem primo, furditatem fubinde, omnium denique fenfuum et functionum animalium abolitionem et necem ipfam intuliffe." Bonet. vol. i. p. 123. ob. 53. In Sandifort Obs. Anatom. Path. tom. i. p. 116. there is an inftance in which the auditory nerve had a cartilaginous tumor adhering to it.

† F. Hoffman. Confult. et Refponf. Caf. xxxix We muft not, however, take his reafoning after what we have feen of the ftructure of the ear, that the vifcid petuita, feparated in the concha, cochlea, and labyrinth, refolved into halitus endeavouring to efcape, produces the fufurrus et tinnitus aurium.

hysteria, the increased sensibility of the organ becomes a source of painful sensation.

In apoplectic affections, with faltering of speech and blindness, there is also deafness; because the affection of the brain is general. With a paralytic state of the muscles of the face, there is deafness of the corresponding ear, if the affection of the nerve be near the brain; which is explained by the strict connection betwixt the auditory nerve and the nervus communicans faciei. From observing the course of the nervus communicans faciei through the temporal bone, and its connections in the tympanum, we understand why, in violent tooth-ach and in the tic douloureuse, we find the eustachean tube and root of the tongue affected. The ear is sometimes affected by sympathy of parts: for example—from foulness of the stomach and bowels; and the same reason may be assigned for the complaint of hypochondriacs, that they are molested with strange sounds. And in the case of intestinal worms, we find the patient complaining of murmuring and ringing in the ears.* Of the organic diseases of the labyrinth, there is little on record. It would appear, that the fluids become often so altered in their consistence as to prove an absolute destruction to the organ. Mr. Cline found in a person deaf from birth, that the whole labyrinth was filled with a substance like cheese.

A disease of the auditory nerve, like that of the retina in the gutta serena, is no unfrequent complaint.†

We ought, at all events, before proposing any operation on the ear, to observe whether the disease be not in the seat of the sense, and such as will not yield to any practice; otherwise, as in the more important operations when done in circumstances which preclude the possibility of success, the public is impressed with its inefficacy and danger, and we are precluded from giving relief on occasions more favourable for our operations.

Deafness, in acute fever, is a good sign; because, say authors, it argues a metastasis of the morbific matter. We should rather say, because it argues a diminution of the morbid sensibility of the brain.‡ But the surcharge of the vessels

* Hoffmann. Med. Confult. Boerhaave. The fympathy is fometimes exerted in another way:—" Ex mufices tonitru aut fola meatus auditorii externi contrectatione, vomitus urinae incontinentia" Sauv.

† Dyfecoea (atonica) fine organorum fonos tranfmittentium vitio evidente. Cullen. Cophofis *Sauv. Cophofis* a *Paracufi* diftinguitur ut *amaurofis* ab *omblyopia* refpectiva. Sauv.

‡ But the difficulty of knowing when the deafnefs is the refult of difeafe, or malconformation in the parts tranfmitting the found to the nerve, and when in the brain and nerve, has led to more uncertainty and confufion with regard to the fpecies and varieties of the diforders of the ear than in the eye; where the tranfparency of the humours affift in the definition.

of the brain or of the auditory nerve will also produce deafness and unusual sensations in the ear: as in suppression of the menses and hæmorrhoids, in surfeit, &c. in which cases it is often preceded by vertigo and head-ach.

There occurs a very curious instance of analogy betwixt the ears and eyes in the following cases:—" A certain eminent musician, when he blew the German flute, perceived at the same time the proper sound of it and another sound of the same rhythm or measure, but of a different tone. His hearing seemed thus to be doubled. It was not an echo; for he heard both sounds at one and the same moment: neither were the sounds accordant and harmonious, for that would have been sweet and pleasant to his ear. Having for several days persisted in his attempts, and always been shocked with this grating sound, he at last threw his flute aside. The day before he first became sensible of this strange affection, he had imprudently walked in a very cold and damp evening, and was seized with a catarrh in the right side. Whence, probably, it arose that the natural tone of that ear was altered: the sound appeared more grave, and dissonant from that received by the left ear. Having recovered from the catarrh, the distinct hearing of his ear was restored."

Sauvage, who relates this case, subjoins another:—" Very lately," says he, "a foreigner came for advice in a similar situation. He complained that when any person spoke to him, he heard the proper sound of the voice, and at the same time another sound accompanying it an octave higher, and almost intolerable to him. As it must have happened that if the accompanying sound had preserved the true octave above the voice, and been synchronous with it, the ear would have received them as one sound, and been pleased with their concord: it is probable that the accompanying sound was not in unison with the true. Sauvage, vol. iii. p. 352.

BOOK III.

OF THE NOSE AND THE ORGAN OF SMELLING.

OF THE SENSE OF SMELLING.

SMELLING seems to be the least perfect of the senses. It conveys to us the simplest idea, and is the least subservient to the others. The sensations it presents to us we can less easily recall to memory; and the associations connected with it are less precise and definite than those of the senses of hearing and seeing.

Animal and vegetable bodies, during their life, growth, putrefaction, and fermentation, and, most probably, all bodies whatever, are perpetually giving out effluvia of great subtlety. Those volatile particles repelling each other, or being diffused in the atmosphere, are inhaled by the nose, and convey to the pituitary membrane of the nose the sensation of smell.

Immediately within the nostrils, there are two cavities separated by the bony partition, which has been already described in treating of the bones. These cavities enlarge as they proceed inward, and open backward into the throat, and, consequently, communicate with the mouth. They extend upwards and sideways into the cells of the bones of the face; and the pituitary membrane is much extended over the surfaces of these winding passages, and over the irregular surfaces of the nose, formed by the projecting cartilages of the æthmoid and lower spongy bones; which, also, have already been sufficiently described.

The cavities of the nose lead into many cells in the bones of the face, which, if not subservient to the organ, assist in giving vibration and tone to the voice. The cavities of the nose are continued upwards into the frontal sinuses, and into the cells of the æthmoid bone; backward and upward into the sphenoid sinus; and upon the sides into the antra highmoriana or sinuses of the upper maxillary bones.

The membrane covering the surface of these bones is called the MEMBRANA SCHNEIDERIANA, the mucous or pituitary membrane. It is of a glandular structure, or is lubricated by the mucus discharged by the follicules on its surface.—This secretion on the surface of the membrane, is to defend its delicate and sensible structure from the effects of the air, while it preserves the sensibility of the surface and the delicate expanded nerve. It seems of a nature to allow the effluvia to penetrate it.

It appears to me, that a very particular provision has been made against the too powerful effect of smells while the membrane is inflamed, and, consequently, in a state of great sensibility. When the membrane is inflamed, the secretion is so altered, that the effluvia do not penetrate so as to effect the nerve in its state of extreme sensibility.

We have already described the course of the first pair of nerves or the olfactory nerves, and also those branches of the common nerves which are distributed to the membrane of the nose. These, it were superfluous to recapitulate here. It was suggested as the most probable opinion, that the olfactory nerve alone is subservient to these parts considered as the organ of smelling, and that the adventitious branches supply merely the common sensibility which the nerves bestow promiscuously over the body. This sensible and nervous membrane, and this glandular and secreting membrane, is extremely vascular, as it is natural a priori to suppose; and this vascularity, this glandular structure, and its exposed state, makes it liable to frequent disease: and, when diseased, when tumours and polypi form in it, we must never forget the extreme thinness and delicacy of the surrounding bones, which, when they are either pressed upon by tumours, or have their membranes eroded, are soon totally destroyed.—It is with manifest design, that the organ which so particularly admonishes us of the effluvia diffused in the air we breathe, should have been placed in the entrance to the canal of the lungs. It is, in some measure, a guard to the lungs, as the sensibility of the tongue guards the alimentary canal. That the humidity of the membrane either preserves the sensibility of the nose, or is a solvent, in which the effluvia dissolving

affect the nerves, is evident; for the sense is lost when the membrane becomes dried. The sensibility is also affected in various ways by too abundant a mucous discharge, or by an alteration of its natural properties; by the infarction and thickening of the membrane, as in ozæna; by obstructions preventing the current of air through the nose, as in polypi, &c.

BOOK IV.

OF THE MOUTH, SALIVARY GLANDS, AND ORGAN OF TASTE.

CHAP. I.

OF THE MOUTH AND TONGUE.

ALTHOUGH it is not necessary to say, that the mouth is "betwixt the nose and chin," that "there are lips serviceable to the purposes of speaking, eating, and drinking;" though it be not necessary to lay it down circumstantially, that there are cheeks on the face, and a tongue in the mouth; yet is there much important anatomy, and very useful knowledge necessary to be acquired here.

Of the TONGUE, it is only necessary to observe its form, and the terms used in its description. The BODY of the tongue consists of the muscular fibres, with intermingled fat and cellular membrane; and the muscles which chiefly compose it, are the linguales, styloglossi, and genioglossi muscles.

The BASE of the tongue is connected with the os hyoides.

The surface applied to the roof of the mouth is the DORSUM; and on this surface there is to be observed a middle line, dividing the tongue into two lateral portions; a division which is very accurately preserved in the distribution of the blood-vessels and nerves of either side. On the dorsum, towards the base, the surface is rough with the papillæ maximæ and foramen cæcum of Morgagni. These papillæ are like small glands seated in little superficial fossulæ, so that their broad mushroom-like heads alone are seen; but they are connected with the bottom of the fossulæ by short stems or necks. This is al-

together a glandular apparatus. The foramen cæcum is, in truth, only an enlarged apparatus of the same kind, for, in the bottom of this foramen, many glandular papillæ stand up; and in its bottom small foramina have been observed, which are generally conceived to be the mouths of small salivary ducts.* This secreting mucous surface begins here, towards the root of the tongue, to resemble the glandular structure of the œsophagus, which, by bedewing the surface of the morsel, fits it for an easy passage through the gullet. In this roughness of the root of the tongue, there seems to be a provision for the detention of the sapid particles, and the prolonging of the sensations of taste.

The PAPILLÆ peculiar to the human tongue, are divided into four classes. 1. These larger papillæ upon the root of the tongue are the truncatæ; and they are often studded on the dorsum of the tongue in a triangular form. 2. The fungiformes are obtuse papillæ found more forward on the tongue; they are little hemispherical tumid papillæ, or of a cylindrical shape, with an obtuse apex. These are interspersed among the 3d division, the most numerous and universally prevalent papillæ, viz. villosi or conicæ. 4. The more important papillæ, however, are those which are endowed with peculiar sensibility to sapid bodies; they are to be distinguished by their superior redness and brilliancy upon the point and edges of the tongue.

The tongue is invested with the cuticle and rete mucosum, like the skin in other parts. The lower surface of the tongue is similar to the general lining membrane of the mouth, being a villous and secreting surface. It is reflected off upon the bottom of the mouth. It forms here the frenulum linguæ. This ligament seems evidently intended to limit the motion of the point of the tongue backwards. I believe a very false opinion has much prevailed, that the shortness of this ligament, or its being continued too far forward toward the point of the tongue, prevents the child from sucking. The tongue, as I conceive, would sufficiently perform the necessary action on the mother's nipple, although its lower surface were universally adhering to the bottom of the mouth. But, observe the bad consequences which may arise from cutting this frenulum, from the obstinate importunity of the nurse, or the weakness of a surgeon. The ranine vein or artery which runs near it may be cut, and the child will continue sucking and swallowing its own blood; and children have actually died, and the stomach has been found

* Vater, who injected these ducts, found them terminating in a gland near the os hyoides; and his opinion was, that they had even a connection with the thyroid gland. Heister was of the same opinion.

distended with blood! But there is another more dreadful accident from this cutting of the frenum linguæ. A child, says Mr. Petit, whose frenum had been cut almost immediately after its birth, was suffocated, and died five hours afterwards. They believed that the operation was the cause of the child's death; they sent for me to open the body. I put my finger into its mouth, and I did not find the point of the tongue, but only a mass of flesh, which stopped up the passage from the mouth into the throat. I cut up the cheeks to the masseter muscles, to see what had become of the tongue; I found it turned like a valve upon the fauces, and the point actually swallowed into the pharynx. "Some time after," continues Mr. Petit, "I was called to the child of Mr. Varin, Sellier du Roi, whose frenum they had cut two hours after its birth, and who, a little after, had fallen into the same situation with the child I have now mentioned, and was nearly suffocated. My first care was, to introduce my finger, the tongue was not, as yet, entirely reversed into the throat. I brought it back into the mouth; in doing which, it made a noise like a piston when drawn out of its syringe." Mr. Petit waited to find the effect of its sucking, and, after hearing the action of deglutition for some minutes, the child fell again into the same state of suffocation. Several times he reduced the tongue, and, at last, contrived a bandage to preserve it in its place; but, by the carelessness of the nurse, the accident recurred, and the child was suffocated during the night.

CHAP. II.

OF THE SALIVARY GLANDS.

THE sources of the saliva are very numerous; the parotid glands or superior maxillary gland, and socia parotidis; the inferior maxillary or submaxillary glands; the sublingual glands; and, (according to the opinion of many,) the glandular folliculcs of the root of the tongue: the palate, and even

the buccinales and labiales, or glands of the cheeks and lips, are also to be enumerated, as sources of saliva.

The PAROTID GLAND, as its name implies, is that which lies near to the ear. It is the largest of the salivary glands; and it is of much importance for the surgeon to observe its extent and connections. A great part of it lies before the ear, and betwixt the ear and jaw. It extends over the masseter muscle, and upward to the zygoma. But there is also great part of it which lies below the tip of the ear, and betwixt the angle of the jaw and the mastoid process. Its surface is unequal, and composed of little masses or lobules of gland, united by a cellular membrane. The duct of this gland was discovered by Needham, and afterwards by Steno: it is very often called Steno's duct. When it is injected with quick-silver, the branches are seen distributed in a most beautiful and minute manner amongst the lobuli of the gland, and similar to the branching of veins. These branches have a direction upward, and unite into a trunk, which passes from the upper part of the gland across the cheek over the origin of the masseter muscle: it then pierces the buccinator muscle, and opens upon the inner surface of the cheek, opposite to the second or third dens molaris. This duct has strong white coats; but, although the mouth of the duct is very small, the duct itself is dilatable to a great size, so that tubes of a considerable size have slipt into it, and been buried in the body of the gland.

The SOCIA PAROTIDIS is a small gland, (which, however, is by no means constant,) seated on the upper side of the duct of the parotid gland, and just under the margin of the cheek-bone. It opens by a lesser duct into the great duct of Steno.—Sometimes, however, instead of one considerable gland, there are several small ones, seated in the course of the great duct, and opening into it by several minute ducts.

OF THE SUBMAXILLARY AND SUBLINGUAL GLANDS. The submaxillary gland is of a regular oval figure; it lies on the tendon of the digastric muscle, and is defended by the angle of the lower jaw, while it is generally connected with, or involves the root of the focial artery. It is regularly lobulated: and its duct passes forward between the genioglossus and mylohyoideus, and under the sublingual gland. The openings of the submaxillary ducts, or ducts of Wharton, are very easily distinguished. They open very near each other on each side of the frenum linguæ, very near the gums of the dentes incisivi; so that they appear as if tied down by the frenum.—When these are excited to discharge their fluids, they become a little erected, their patent mouths are seen distinctly, and the

tortuous course of their canal in the bottom of their mouth may be observed.

The SUBLINGUAL GLAND is of a flat and elongated form; it lies close under the tongue between the geniohyo-glossus and mylo-hyoideus muscles. It is the smallest of the three great salivary glands. The two sublingual glands stretching closely under the tongue, they are separated from the mouth only by the membrane of the mouth. They have no large duct, but open by small lateral ducts, with loose pendulous mouths upon the lower surface of the tongue. Besides the lesser glands, which every where are found under the lining membrane of the mouth, Heister, Verdier, and M. de Bordeu, have described a glandula molaris, seated betwixt the buccinator and masseter muscles.

From the general surface of the lips, tongue, cheek, and palate, there is a fluid exhaled. This exhaling surface, and all those glands, are excited to action by the same stimulus with the membrane of the mouth. The saliva moistens the surface of the mouth, assists in manducation, and preparing the food to be swallowed and acted upon by the stomach, and accelerates digestion. As the mouth is an exhaling surface, so is it an imbibing and absorbing surface.

CHAP. III.

VELUM PALATINUM; UVULA; ARCHES OF THE PALATE; AND AMYGDALÆ.

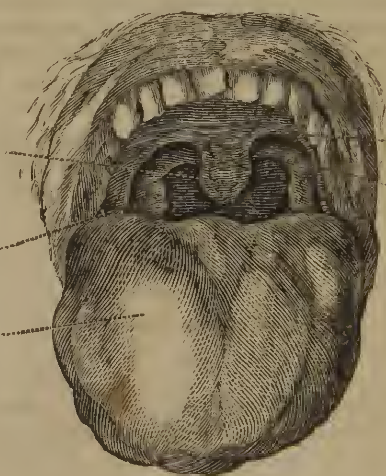
THE VELUM PENDULUM PALATI is the vascular and fleshy membrane, which, hanging from the bones of the palate, divides the mouth from the fauces and throat. It is not a simple membrane, but has betwixt its laminæ many glands, which open upon its surface by little patent follicules, and is thickened and strengthened by muscular fibres: so that it is more of a fleshy partition, stretching backward and eking out the palate, than a hanging membrane.

The edge of the velum palati is not square, but turned into elegant arches; and, from the middle of the arches of the pal-

ate, hangs down the UVULA, so named from its resemblance to a grape. It is a large, soft, and glandular papilla, peculiarly irritable and moveable, having in it muscular fibres, and hanging from the moveable soft palate. It seems to hang as a guard over the fauces, and, by its sensibility, in a great degree governs the operation of these parts.

The ARCHES OF THE PALATE OR FAUCES descend on each side from the velum palati. They are muscular fibres, covered with the soft vascular and follicular membrane of the fauces.* There are two on each side. These arches stand at some distance from each other, so that the isthmus of the fauces resembles the double-arched gateway of a citadel, or the arched roof of a cathedral, with the uvula hanging as from the central union of four semicircular arches.

Fig. 20.



Behind the soft palate is the opening of the nose backward into the throat. Now, the use of the velum is that in swallowing it may be drawn up like a valve upon the posterior opening of the nose ; and there being, at the same time, an action of the arches of the palate, the whole is brought into a funnel-like shape, directing the morsel into the pharynx and gullet. In this action, the direction of the food assists, but,

* See vol. I. Constrictor Isthmi faucium and Palato-pharyngeus.

in vomiting, the valvular-like action of the velum is not so accurate; and often the nose is assailed with the contents of the stomach.

AMYGDALÆ. Under the velum palati, and betwixt the arches of the palate on each side, lies a large oval gland of the size and shape of an almond. These are the tonsils or amygdalæ. The amygdala is a mucous gland: it is loosely covered with the investing membrane of these parts: its surface is seen, even in a living person, to be full of large cells like lacunæ; these communicate; and the lesser mouths of the ducts open into them. The gland is of a soft relaxed nature, adapting itself to the extensive motion of those parts. From this naturally loose texture, and from its being a vascular and secreting body, exposed to the immediate vicissitudes of weather, it is often inflamed, and greatly impedes the action of the surrounding muscular fibres in the action of deglutition. The use of the amygdala is evidently to lubricate the passage of the throat, and facilitate the swallowing of the morsel; and, for this reason, are the mouths of its ducts cellular and irregular, that they may retain the mucus until ejected by the action of deglutition. In this operation, the amygdalæ are assisted by numerous lesser glands, which extend all over the arches of the palate and pharynx. But these are parts which come again to be recapitulated, as introductory to the account of the structure of the œsophagus and stomach, in the succeeding volume.

CHAP. IV.

OF THE SENSE OF TASTING.

ON the surface of the tongue are to be observed erect papillæ. In these the extremities of the gustatory nerve are expended, and they are the seat of the sense of tasting. These papillæ are in the true skin of the tongue, and are extremely vascular. They are covered by the rete mucosum, and a very fine cuticle, and indeed they have much resemblance to the papillæ of the skin; while, betwixt these papillæ, there is a fleece

or down bearing a perfect analogy to the villi of the skin. The papillæ, which are the organs of taste, are to be seen on the point and edge of the tongue, and consist of a pretty large vascular soft point which projects from an opaque and white sheath. If we take a pencil and a little vinegar, and touch or even rub it strongly on the surface of the tongue, where those papillæ are not, the sensation only of a cold liquid is felt; but when you touch one of these papillæ with the point of the brush, and at the same time apply a magnifying glass, it is seen to stand erect and rise conspicuously from its sheath, and the acid taste is felt to pass as it were backward to the root of the tongue. The exquisitely sensible papillæ are placed only on the point and edge of the tongue; for the middle of the tongue is rough, and scabrous, not to give the sensation of taste, but to force the sapid juices from the morsel, or break down the solids against the roof of the mouth, and assist in their solution. The more delicate and vascular papillæ would be exposed to injury if situated on the middle of the tongue. Before we taste, the substance dissolved in the saliva flows over the edges and point of the tongue, and then only comes in contact with the organ of taste.

It would appear, that every thing which affects the taste must be soluble in the saliva; for without being dissolved in this fluid, it cannot enter readily into the pores and inequalities of the tongue's surface.

A curious circumstance, in the sense of taste, is its subserviency to the act of swallowing. When a morsel is in the mouth and the taste is perfect, our enjoyment is not full: there follows such a state of excitement in the uvula and fauces, that we are irresistibly led to allow the morsel to fall backward, when the tongue and muscles of the fauces seize upon it with a voracious and convulsive grasp and convey it into the stomach.—The measure of enjoyment is then full. This last short-lived gout is the acmé. Were not this appetite of the throat and uvula connected with the action which impels the food into the stomach, the complete enjoyment of the sense of taste alone would preclude the brutal resource of the Roman feasts: but as it is, the connection of the stomach and tongue is such, that the fullness of the stomach precludes the further enjoyment of the sense of taste. The senses of smelling and taste have their natural appetites or relish; but they have also their acquired appetites, or delight in things which to unsophisticated nature are disagreeable: so that we acquire a liking to snuff, tobacco, spirits, and opium. "Nature, indeed, seems studiously to have set bounds to the pleasures and pains we have by these two senses, and to have con-

fined them within very narrow limits, that we might not place any part of our happiness in them; there being hardly any smell or taste so disagreeable that use will not make it tolerable, and at last, perhaps, agreeable; nor any so agreeable as not to lose its relish by constant use. Neither is there any pleasure or pain of these senses which is not introduced or followed by some degree of its contrary which nearly balances it. So that we may here apply the beautiful allegory of the divine Socrates: "That although pleasure and pain are contrary in their nature, and their faces look different ways, yet Jupiter hath tied them so together, that he who lays hold of the one draws the other along with it."

BOOK V.

OF THE SKIN AND OF THE SENSE OF TOUCH.

OF TOUCH AND OF THE SKIN.

BY the sense of touch we perceive several qualities, and of very different kinds: hardness, softness, figure, solidity, motion, extension, and heat and cold. Now, although heat be a quality, and cold the privation of that quality, yet in relation to the body, heat and cold are distinct sensations. But in a more precise acceptation of the term, the sense of touch is said to be the change arising in the mind from external bodies applied to the skin, and more especially to the ends of the fingers.

To understand the organization adapted to this sense, we must premise, in a short view, the structure of the skin.

OF THE SKIN.

The skin is divisible, by the art of the anatomist, into four laminæ or membranes, distinct in texture and appearance as in their function or use, viz. the cuticle, or epidermis; the corpus mucosum, or reticular tissue; the cutis vera dermis, or true skin: but from this last there is separated a vascular membrane, below which is the organized surface of the true skin.

The CUTICLE OR EPIDERMIS, OF SCARF SKIN, is the most superficial lamina of the skin: it is a transparent and insensible pellicle which serves, in some degree, to resist the impression of external bodies on the surface of the body, and to blunt the otherways too acute sensation of the cutis vera. In

man it is very thin, unless in those parts which are exposed to the contact of hard bodies, as the palms of the hands and soles of the feet. The thickness of the cuticle there, however, is not altogether the effect of labour and walking, but there is even in the fœtus a provision for the defence of the skin in these places. This is particular, that by labour or continued pressure on the cuticle it does not abrade and become thin and tender, but thicker, harder, and the part more insensible, so as even to acquire a horny hardness and transparency. Of this we have an example in the hands of smiths, and in a remarkable manner in the feet of those who have been accustomed to walk bare-foot on the burning sands. It is thus a protection in a state of nature; but when the foot comes to be unnaturally pinched in shoes, the hard leather works perpetually on a point of the toes, excites the formation of cuticle in the skin below, which thrown outward by succeeding layers of cuticle, at last forms a corn or clavus, and which, like a small nail, has a broad head with a conical point shooting into the tender skin.

The cuticle is perforated by the extremities of the perspiring and absorbing vessels, and by the ducts of the glands of the skin. Indeed, when the small pores of the skin or foramina are examined narrowly, the cuticle is seen to form sheaths which enter into them, and which, when torn out, are like little tubes having a perforated point.

When, by maceration, the cuticle is separated from the skin, as we draw it off we see little processes of the cuticle, which enter into the pores of the skin.

Mr. Cruickshanks enumerates three classes of processes: there appear evidently two. The first lines the pores through which the hairs pass: these are the longest, and generally have the longest diameter. The second class is easily distinguished on the inside of the cuticle, which covers the palms of the hands or soles of the feet, or indeed on any part of the cuticle; and they appear in regular order on those parts of the cuticle which correspond with the parallel or spiral ridges of the cutis. The surface of the cuticle is uniform next the skin; but, on the outer surface, it is rough and squamous. These squamæ are the portions of the cuticle, which, breaking up, are rubbed off; and thus there is a perpetual change, by the formation of new cuticle under the old, and the abrasion or disquamation of the old surface.

In youth, the cuticle is thin and transparent; in old age, it becomes thick, rough, and furrowed:

——— deformem pro cute pellem
Pendenteisque genas et taleis adspice rugas

Qualeis umbriferos ubi pandit tabraca faltus
In vetula fcalpit jam mater fimia bucca.

The NAILS are naturally connected with the cuticle, for they remain attached to it, and separate from the true skin by maceration and beginning putrefaction. The nails are to give firmness and resistance to the points of the fingers. Although they take a very universal adhesion, it is chiefly from the root that they grow and shoot out to the point of the fingers, to which they adhere firmly. Over the root of the nail the cuticle projects, and under it the rete mucosum is extended; and under this, and defended by it, are the papillæ of the skin also.

Like the cuticle, the nails are without vessels or sensation: they are undergoing a perpetual growth, and are worn down by labour. When cherished, they grow to an amazing length, and curve a little over the points of the fingers; and serve, in some nations, as a most unequivocal sign of perfect idleness and consequent gentility, since the fingers become absolutely useless. By disease, I have seen very large crooked horns projecting from the stool of the nail of the toes. They were thus monstrously increased by superimposed laminæ shoved off by the more recent ones.

OF THE HAIRS.

The hairs grow from a bulbous root, seated in the cellular membrane. This bulb is vascular, and has connection, by vessels, with the cellular texture. It consists of a double membrane; the outer is a kind of capsule which surrounds the other, and stops at the pore in the skin, and does not form part of the hair. Betwixt these capsules, there is a cellular tissue, and the space is commonly found filled with a bloody fluid. In the bottom of the inner sac, there is a small body, called monticule by Duverney, from which the hair is seen to arise; and if this is left when the bulb of the hair is pulled out, the hair will be regenerated.

The root of the hairs, says Mr. Winslow, is covered by a strong white membrane, which is connected with the skin and cellular membrane. Within the root, there is a kind of glue, some fine filaments of which advance to form the stem which passes through the small extremity of the bulb to the skin.—As the stem passes through the root, the outer membrane is elongated in form of a tube, which closely invests the stem and is entirely united with it. And many authors agree, that the hair does not perforate the cuticle, but takes from it merely a vagina which accompanies it.

RETE MUCOSUM.

The rete or corpus mucosum, lies betwixt the cuticle and the surface of the true skin. It is a mucous layer, pervaded by the little fibrillæ passing betwixt the skin and cuticle. I consider it as a soft bed to envelope and preserve the papillæ of the skin, and as intended to become cuticle in due succession. It was considered, by Albinus, as of a nature adapted to imbibe the fluids through the cuticle, and as a production of the epidermis. M. Meckel believed it to be only a mucous fluid, inspissated into the form of a membrane ; and that it was dissolved by putrefaction, while the skin and cuticle remained firm. It is the seat of colour in the skin, and is of a white transparency in the albino, and in the inhabitants of temperate climates. It is black in the negro ; copper-coloured in the mulatto ; yellow in the Egyptian. It is supposed to preserve the negro from the heat of the climate ; but I conceive that the power of resisting the baneful effects of warm climates, must be looked for in other constitutional peculiarities : for certainly a surface which absorbs the light must produce heat more rapidly than a white one, which repels it. The ladies know that the effect of a black veil, in intense sun-shine, is to scorch the cheeks. The rete mucosum changes its shades of colour in Europeans, from the effect of light, and sometimes makes changes in the constitution, as in the colour of the areolæ which surround the nipple.

While the rete mucosum has its peculiar use of defending the delicate surface of the papillæ of the skin, I conceive it to be undergoing a perpetual change ; to be thrown off in succession from the vascular surface of the skin, and in its turn to form the cuticle by its outer layers. The inner surface of the rete mucosum is softer and more pulpy, the outward surface more allied to the cuticle, which gives occasion to Mr. Cruickshanks to say it is double.

Under the rete mucosum and on the surface of the skin, there is a soft vascular membrane, which is still above the porous and glandular true skin. It was first demonstrated by injections in subjects who had died of small-pox, and is also so much strengthened by other inflammatory actions of the vessels of the skin, as to be capable of demonstration. It was at first supposed that this vascular membrane was the rete mucosum successfully injected ; but afterwards it was found, that this vascular membrane existed independently of the rete mu-

cosum.* Mr. Cruickshanks conceives that it is cuticle in its state of formation, and that the rete mucosum is in fact a cuticle advancing to the state of perfect maturation. But I should rather believe that this is a vascular surface, not changeable, nor losing its vascularity to be thrown off in form of rete mucosum; but, in itself, the organized surface, which is to form the rete mucosum, and which excretion does in succession become cuticle. This vascular surface of the skin, for such I must suppose it, although it be capable of being separated by long maceration and putrefaction, into something like a distinct membrane, is the seat of the small-pox pustule, and probably of many other cutaneous diseases.

There are three laminæ above the true skin, distinguished by their character; the cuticle, the rete mucosum, and the vascular membrane: but as some have divided the rete mucosum into the lamina, Mr. Cruickshanks has separated two vascular layers from the surface of the skin. They, who are fond of such minute subdivisions, may thus enumerate five laminæ or membranes, before coming to the porous surface of the true skin.

OF THE TRUE SKIN.

The true skin is the dense, elastic, and vascular membrane which is under these outer laminæ, already treated of. While it has firmness, strength, and elasticity to defend the body; it is also an organized surface, as important in its function and the healthy action of the system depending upon it nearly as closely as on the action of the lungs and surface of the intestines.

The skin is dense on the outer surface, while the internal layers are loose, and gradually degenerate into the cellular substance. On the lips, eye-lids, &c. the skin becomes thin and transparent.

We have to attend to the pores and villi of the skin; on narrowly observing the surface of the skin, we find it irregularly porous. These are the ducts of sebaceous glands, which are lodged in the skin. They transmit the hairs also, and are the perspiring and, probably, the absorbing pores; or, at least, within these larger pores it is probable the absorbing and transpiring vessels terminate. These pores are most remarkable about the nose, mouth, palms of the hands, and soles of the

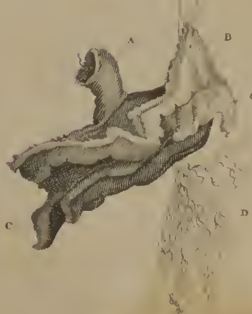
* Mr. Baynham, who discovered this vascular surface, conceived that he had injected the rete mucosum. We are to find the further elucidation of this piece of anatomy from Mr. Cruickshanks.

feet. Into these pores of the true skin, as we have mentioned, little sheaths of the cuticle enter, and through these sheaths the perspiring matter must consequently escape. But, in death, the action of the perspiring vessels ceasing, the pores of the cuticle are no longer pervious to the fluids, and there is no perspiration or exudation through them.

The vili of the skin project above its surface, like the pile of velvet. They vary much in size, and are, in some places, very much prolonged. They conduct the sensible extremities of the cutaneous nerves to form the organ of the sense of touching; and, like the papillæ of the tongue, they suffer an erection and excitement preparatory to the reception of the impression.

Fig. 1.

Fig 2



EXPLANATION

OF THE

PLATES.

PLATE V.

Fig. 1.

THE eye with the cornea cut away, and the sclerotic coat dissected back*.

a. The optic nerve.

b. The sclerotic coat dissected back, so as to show the vessels and nerves of the choroid coat.

c c. The ciliary nerves seen piercing the sclerotic coat, and passing forward to be distributed to the iris.

d. A small nerve passing from the same source to the same destination, but appearing to give off no branches.

e e. Two of the venæ vorticosæ.

f. A point of the sclerotic coat through which the trunk of one of the veins had passed.

g. A lesser venous trunk.

h. The orbiculus ciliaris of Zinn ; the ciliary ligaments of others.

i. The iris.

k. The streight fibres of the iris.

l. A circle of fibres or vessels which divide the iris into the larger circle k, and the lesser circle m.

m. This points to the lesser circle of the iris.

n. The fibres of the lesser circle.

o. The pupil.

* See Zinn, Tab. iv.

Fig. 2.

A dissection of the coats of the eye, as they appeared when hung in spirits.

A. The OPTIC NERVE.

B. The SCLEROTIC COAT folded back.

C. The CHOROID COAT hanging by its attachment to the sclerotic coat.

D. The vessels of the RETINA seen as they appeared suspended in the fluid; the medullary part of this coat being washed away.

Explanation of Plate VI.

Fig. 1.

The LENS covered with its capsule, and minutely injected in the fœtus calf.

A. The ARTERIA CENTRALIS RETINÆ.

B. The fringe remaining with the margin of the lens from the attachment of the vessels of the ciliary body.

Fig. 2.

This figure shews the attachment of the capsule of the lens to the membrana pupillaris, in the fœtus calf.

A. The capsule of the lens very minutely injected ; the lens has been allowed to escape, and the membrane hangs by its attachment to the membrana pupillaris.

B. That part of the capsule which covers the fore part of the lens ; in which, not a vessel is to be seen.

C. The MEMBRANA PUPILLARIS, very minutely injected.

D. The IRIS, to the circle of which, the membrana pupillaris is seen to be attached, and, consequently, to close the pupil.

E. The CILIARY PROCESSES.

Fig. 3.

The CILIARY PROCESSES, the IRIS, and MEMBRANA PUPILLARIS, as they appear in the human fœtus of the seventh month.

Fig. 1.

Fig. 2

Fig. 3

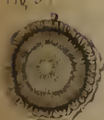


Fig. 4

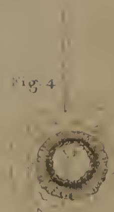


Fig. 5.

Bell del. Lenev sc.

Fig. 1.

Fig. 2.

Fig. 3.

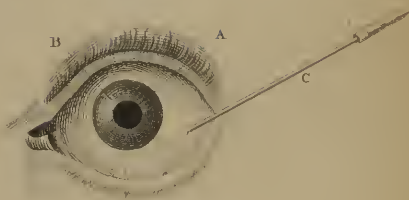


Fig. 4.

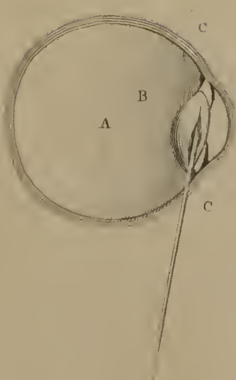


Fig. 5.

Bell del. Liney.

Fig. 4.

The appearance of a vessel which took its course across the pupil in the full grown fœtus, indicating, that the membrana pupillaris was still present, although it had become pellucid.

Fig. 5.

A section of the optic nerve, to show its great degree of vascularity.

A. The body of the nerve quite red with injection.
B. The coat of the nerve.

Explanation of Plate VII.

Fig. 1.

The representation of an eye with a cataract, dissected.

A. The cornea cut from the sclerotic coat, and hanging by a shred.
B. The sclerotic coat.
C. The iris.
D. The opaque lens or cataract, it is seen to have formed an adhesion with the iris.

Fig. 2.

This figure represents the effect of couching a soft cataract. The needle, instead of depressing the cataract, cut it into three pieces.

A A. The cut edge of the sclerotic coat.
B. The choroid coat, and ciliary processes.
C. The cataract adhering to the ciliary processes in three distinct pieces.

Fig. 3.

This figure represents the place into which the couching needle must be introduced.

A. The pupil seen through the transparent cornea.

B. The IRIS.
C. The NEEDLE, with the handle elevated, so as to depress the point.
D. The lens and point of the needle in outline; this represents the position of the lens when depressed: to complete the operation, it must be carried a little back before withdrawing the needle.

FIG. 4.

A scheme, shewing the bad effect of introducing the needle near the margin of the cornea.
A. The VITRIOUS HUMOUR.
B. The LENS.
C C. The CILIARY BODY; on the lower part, torn by the needle.
D D. The IRIS.
E. The anterior chamber of the aqueous humour.

FIG. 5.

Shows the situation of the cataract when depressed.
A. The ANTERIOR CHAMBER of the aqueous humour.
B. The POSTERIOR CHAMBER of the aqueous humour.
C. The iris.
D. The VITRIOUS HUMOUR occupying the seat of the lens.
E. The depressed lens or cataract.

EXPLANATION OF PLATE VIII.

Showing some varieties in the structure of the ear in the lower animals.

FIG. 1.

The ear of the lobster.
A. The membrane which covers the projecting mouth of the shell containing the organ of hearing.
B. A transparent pulp or vesicle, upon the bottom of which, the web of the nerve is expanded.
C. The inside of the shell containing the organ, which is, of course, represented broken open.

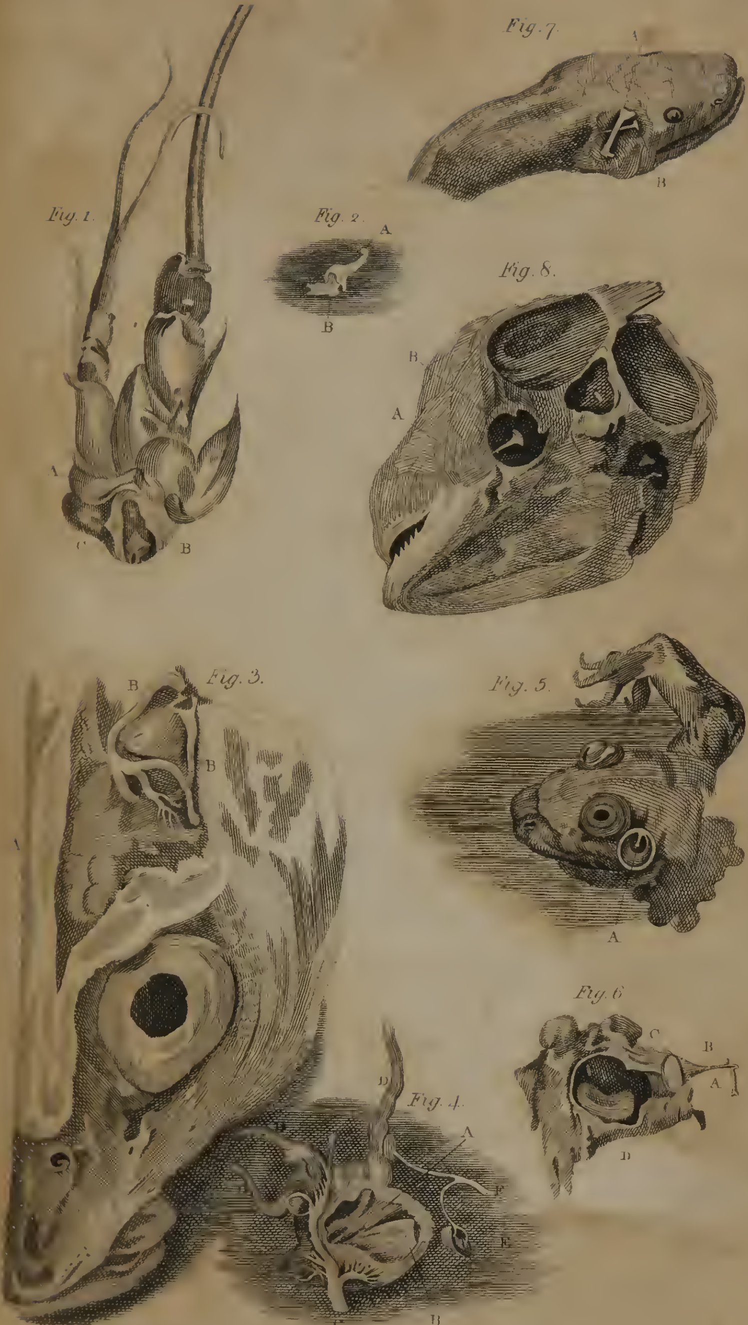


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6
Fig. 7.
Fig. 8.

Fig. 2.

This represents a little bone which is suspended in contact with the pulp of the nerve, and which is seen but imperfectly in the first figure.

A. The bone.

B. An elastic membranous, or rather, cartilaginous substance, by which the bone is suspended.

Fig. 3.

The head of a haddock with the bones broken up, to shew the brain and semicircular canals.

A. The BRAIN.

C. The SEMICIRCULAR CANALS.

Fig. 4.

The organ of hearing taken out and displayed.

A. The SACCULUS VESTIBULI.

B. The bony concretion which lies within, and which, by its vibration, increases the impulse.

C. The AURITORY NERVE passing to be distributed on the sacculus vestibuli, and the extremities of the semicircular canals.

D D D. The three SEMICIRCULAR CANALS.

E. One of the extremities of the semicircular canals in which the branch of the nerve is seen to be expanded.

F. A lesser division of the auditory nerve.

Fig. 5.

The head of a frog with the skin taken off: and we now see the cavity of the tympanum in this animal, over which the common integuments of the head spread tense, so as to answer the purpose of the membrana tympani.

A. The point of a little elastic bone which is attached behind the tense integuments, and receives their vibration.— Its further connections are seen in the next figure.

Fig. 6.

A magnified view of the internal structure of the frog's ear.

A. The first bone, which is attached to the skin.

B. The second bone, which has its inner extremity enlarged

so as to fill up the foramen ovale, which leads into the inner cavity of the ear.

C. The great inner cavity of the ear of this animal, answering to the vestibule of the more perfect structure.

D. A chalky concretion which lies within this cavity.

FIG. 7.

The head of a serpent.

A. A bone connected with the lower jaw.

B. A bone which passes from the integuments (behind the large bone A) to the opening into the cavity of the ear, and which, of course, receives and conveys the vibration of sound into the cavity which contains the expanded nerve.

FIG. 8.

The HEAD of the LAND TORTOISE.

A. A large scale which serves the use of the membrane tympani.

B. A single bone which is seen to pass through the cavity of the tympanum: it is attached by an elastic brush of fibres to the scale A, and is enlarged to a head upon its inner extremity. This, filling up the foramen of the inner cavity, conveys the vibration.

EXPLANATION OF PLATE IX.

In this plate, the anatomy of the bones of the human ear is explained.

FIG. 1.

We have here the bones which form the chain betwixt the membrane of the tympanum and the membrane of the foramen ovale.

A. The MALLEUS.

B. The INCUS.

C. The STAPES.

Fig 2

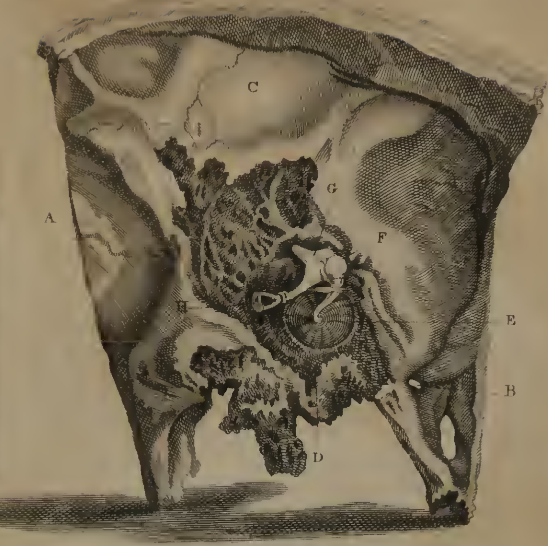


Fig 1

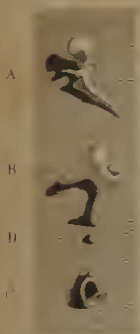


Fig. 4.

Fig. 3.

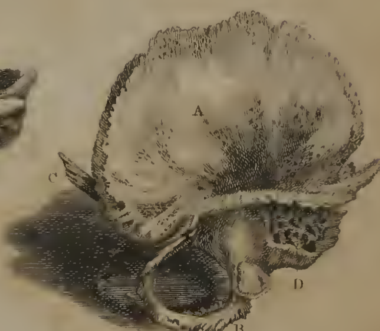


Fig. 5.

Fig. 6.

D. The OS ORBICULARE which forms the articulation betwixt the incus and stapes.

FIG. 2.

In this figure, we have a view of the inside of the temporal bone, the petrous portion being broken away: we see the cavity of the tympanum, the membrane of the tympanum, and the chain of bones.

A. The groove for the lodgement of the lateral sinus.
B. The hole in the sphenoid bone for the passage of the artery of the dura mater.
C. The petrous portion of the temporal bone.
D. The irregular CAVITY of the TYMPANUM laid open by the breaking off of the petrous part of the temporal bone.
E. The MEMBRANE of the TYMPANUM closing the bottom of the meatus auditorius externus.
F. The MALLEUS, the long handle of which is seen to be attached to the membrane of the tympanum E.
G. The INCUS, united to the great head of the malleus F.
H. The STAPES, which is seen to be articulated with the long extremity of the incus through the intervention of the os orbiculare.

FIG. 3.

Shows the division of the temporal bone into the squamous and petrous portions.

FIG. 4.

A. The SQUAMOUS PART of the temporal bone.
B. The CIRCULAR RING, which forms the meatus auditorius externus in the child.
C. The ZIGOMATIC PROCESS.
D. Cells, which afterwards enlarge into those of the mastoid process.

FIG. 5.

The petrous portion of the bone, with a view of the tympanum.

The CAVITY of the TYMPANUM.
B. MASTOID CELLS.

D. The FORAMEN OVALE, into which the stapes (see fig. 1. C. and fig. 2. H.) is lodged.

E. The more irregular opening of the FORAMEN ROTUNDUM.

FIG. 6.

Represents the labyrinth of the human ear, with the solid bone which surrounds it cut away.

A. The FORAMEN OVALE.

B. The three SEMICIRCULAR CANALS.

D. The COCHLEA.

E. The tube, which conducts the portio dura of the seventh pair through the temporal bone.

FIG. 7.

Explains the manner in which the lamina spiralis divides the cochlea into two scalæ, and the opening of the one scala into the common cavity of the vestibule, and the termination of the other in the foramen rotundum.

A. The bone broken, so as to show the cavity of the tympanum.

B. The FORAMEN OVALE.

C. Cellular structure of the bone.

D. The FORAMEN ROTUNDUM.

E. One of the SCALÆ of the cochlea, which is seen to terminate in the foramen rotundum.

F. The other scala, which is seen to communicate with the vestibule.

EXPLANATION OF PLATE X.

These two figures are taken from the beautiful plates of Professor Scarpa, and illustrate the soft parts contained within the osseous labyrinth, and the distribution of the nerves.

FIG. 1.

There is seen the membranous semicircular canals, their common belly, and the distribution of the acaustic or auditory nerve.

a. The AMPULLA of the superior membranous semicircular canal.

Fig. 1.

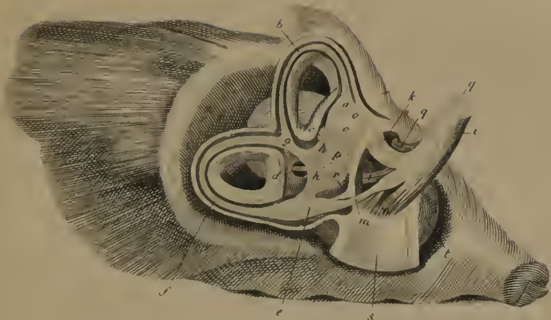
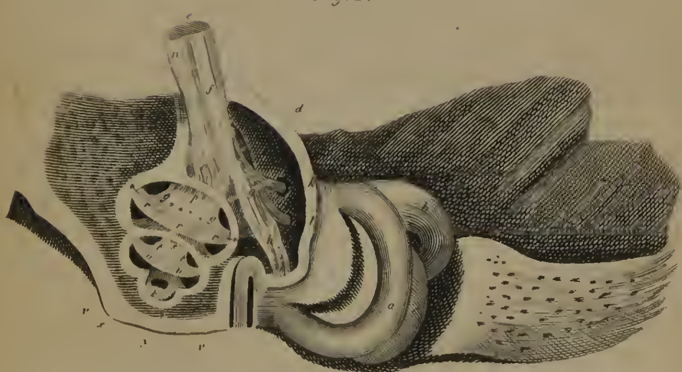


Fig. 2.



Leney sc.

b. The SUPERIOR MEMBRANOUS SEMICIRCULAR CANAL.
c. The AMPULLA of the external membranous canal.
d. The other extremity of the external canal.
e. The AMPULLA of the posterior membranous semicircular canal.
f. The POSTERIOR SEMICIRCULAR CANAL.
g. The common canal of the superior and posterior canal.
h h. The sac common to the membranous semicircular canals, viz. the ALVEUS COMMUNIS.
i. The body or trunk of the ACUSTIC NERVE.
k. The larger branch of the nerve.
l. A filament of the nerve to the sacculus vestibuli.
m. The lesser branch of the acustic nerve.
n. A filament of the cochlea.
o o. Filaments of the larger branch of the acustic nerve to the ampullæ of the superior and exterior semicircular canals.
p. The expansion of the nerve on the common alveus.
q q. NERVUS COMMUNICANS FACIEI or PORTIO DURA.
r. The beginning of the spiral lamina of the cochlea.
s. The osseous canal of the nerve, which forms part of the foramen auditorius internus.
t. The COCHLEA.

FIG. 2.

The distribution of the nerve in the cochlea seen by a section of the internal auditory canal and cochlea.

a. The SUPERIOR OSSEOUS SEMICIRCULAR CANAL.
b. The posterior osseous semicircular canal.
c. The external osseous semicircular canal.
d. The bottom of the great FORAMEN AUDITORIUS INTERNUS.
e. The trunk of the great acustic nerve.
f. The ANTERIOR FASCICULUS of the acustic nerve.
g. A plexiform twisting in the anterior fasciculus of the nerve.
h. A gangliform swelling of the nerve.
i. The greater branch of the anterior fasciculus.
k. The lesser branch.
l. A filament of the anterior fasciculus to the hemisperical vesicle of the vestibule.
m. A branch to the beginning of the lamina spiralis.
n. The POSTERIOR FASCICULUS of the acustic nerve.
o. The filaments about to enter the tractus spiralis foraminulosus.

p. These nerves seen upon the modiolus.
q q. The filaments of the nerve passing forward wixt the two planes of the lamina spiralis.
r r. Their termination on the soft part of the lamin . iralis.
s. The nerves expanded on the second gyrus of th : modiolus.
t t u u. Their further distribution on the lamina sp ralis.
v v. The INFUNDIBULUM.
x y. The last turn and termination of the lamina spi... is in the infundibulum.

END OF THE THIRD VOLUME.

THE

ANATOMY

OF THE

HUMAN BODY.

IN FOUR VOLUMES,

ILLUSTRATED WITH ONE HUNDRED AND TWENTY-FIVE ENGRAVINGS,

VOLUME IV.

CONTAINING THE

ANATOMY OF THE VISCERA OF THE ABDOMEN, THE PARTS IN THE MALE AND FEMALE PELVIS, AND THE LYMPHATIC SYSTEM.

PART I.

OF THE ABDOMINAL VISCERA.

INTRODUCTORY VIEW OF THE SYSTEM OF THE VISCERA, AND OF THE STRUCTURE OF GLANDS.

CHAP. I.—Of the Stomach and Intestines..........CHAP. II.—Of the Liver, Spleen, Pancreas, and Kidney.

PART II.

OF THE MALE PARTS OF GENERATION.

CHAP. I.—Of the Parts within the Pelvis..........CHAP. II.—Of the Parts connected with the Viscera of the Pelvis, but situated without it.

PART III.

OF THE PARTS OF THE FEMALE PELVIS.

PART IV.

OF THE LYMPHATIC SYSTEM.

With an Appendix.

By CHARLES BELL,

FELLOW OF THE ROYAL COLLEGE OF SURGEONS OF EDINBURGH.

NEW-YORK:

PRINTED AND SOLD BY COLLINS AND PERKINS, NO. 189, PEARL-STREET.

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PART IV.

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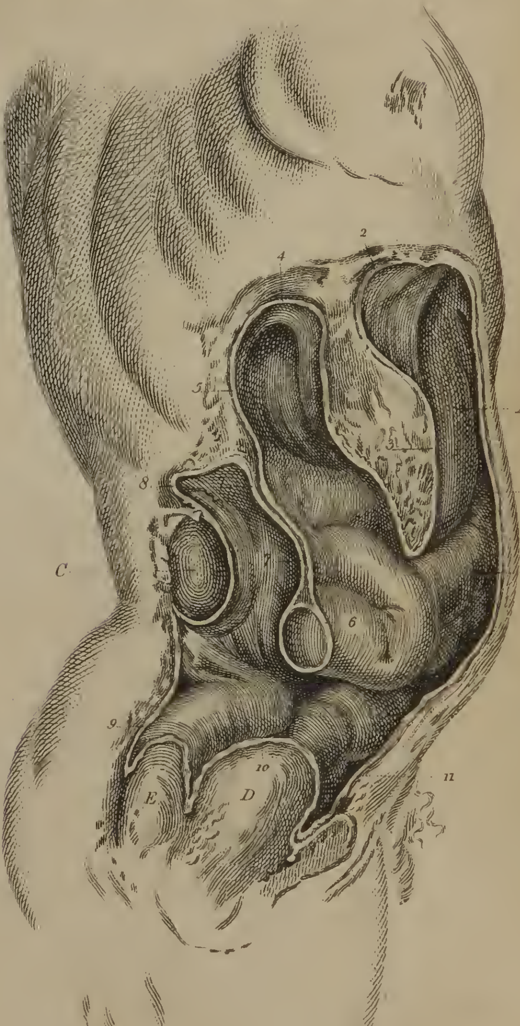
CHAP. I.

CHAP. II.

Plan Drawing of the Abdomen Showing the Inflections of the Peritoneum



Bell del.t Leney sc.t

EXPLANATION

OF THE

PLATES.

PLATE I.

THIS plate represents an ideal section of the abdomen, and the cut edge of the peritoneum is represented by the white line.

A. The LIVER.
B. The INTESTINES.
C. The KIDNEY.
D. The BLADDER of URINE.
E. The RECTUM.

1. The PERITONEUM, where it lines the abdominal muscles.
2. The PERITONEUM, where it is reflected to form the ligament of the liver.
3. The liver being represented cut through, we can trace the lamina of the ligament 2, over its surface 3, forming the peritoneal coat of this viscus.
4. Marks the PERITONEUM reflected from the liver upon the diaphragm.
5. Here the PERITONEUM is reflected off from the spine, to form one of the lamina of the mesentery.
6. The peritoneal coat of the intestine, which we can trace round the circle of the gut until it unites again with the mesentery.

7. 7. The PERITONEUM, forming the lower lamina of the mesentery.

8. The PERITONEUM at that part where it is reflected, and covers the kidney.
9. The PERITONEUM is here descending upon the rectum E, we see it reflected over the gut, and descending again betwixt the rectum and bladder.

10. The PERITONEUM where it forms a coat to the fundus of the bladder.
11. At this part we see the peritoneum reflected up upon the os pubis, and from that we trace it to fig. 1. Thus we see, that the peritoneum can be traced round all its various inflections and processes; which shews, that it forms one continuous sac, and that the intestines and the liver are equally on the outside of this membrane with the kidney.

EXPLANATION OF PLATE II.

This Plate represents the epididimis and testicle, injected with quicksilver, and dissected.

A. The body of the testicle with the tunica albuginea dissected off.
B. B. The seminal vessels in the body of the testicle, or TUBULI TESTIS.*
C. The RETE TESTIS formed by the union of the vessels B. B.
D. The VASA EFFERENTIA, which as they proceed from the testicle, are convoluted in a conical figure, and are called the VASCULAR CONES.
E E. The EPIDIDIMIS formed of the union of the vascular cones: it is a little dissected and spread out.
F. The vas deferens.

EXPLANATION OF PLATE III.

This Plate represents the prostate gland, vesiculæ seminales, and lower part of the bladder, the parts being previously hardened in spirits, the vesiculæ were afterwards cut open.

A A. The body of the PROSTATE GLAND; it is that lower part of the gland which can be felt through the rectum.
B. The prostate gland is here cut into and dissected, in following the ducts of the vesiculæ.

* Where the tubuli are emerging to form the rete vasculosum, or rete testis, they are called the *vasa recta.*

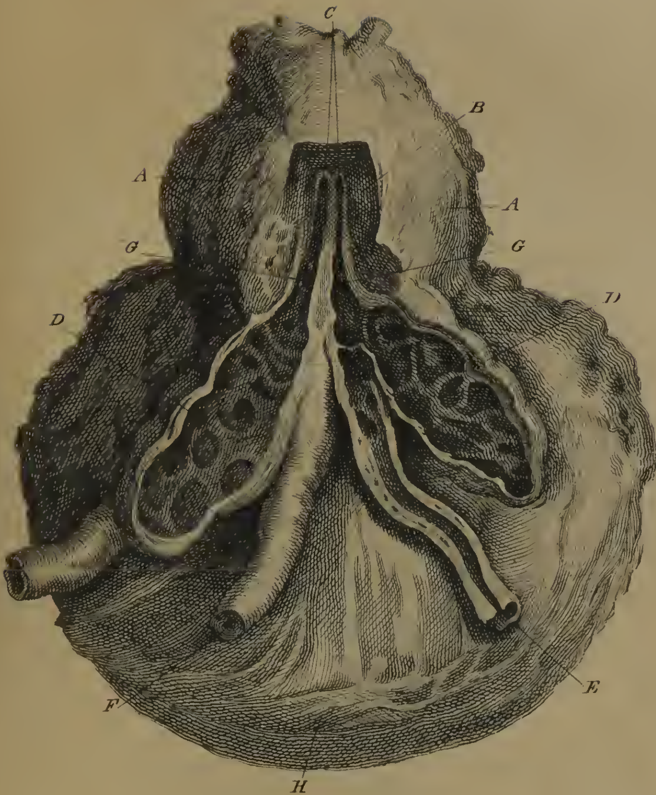
Vol. IV. Plate II.

Bell del.

Lewis sc.

Bell del.

Lowry sc.



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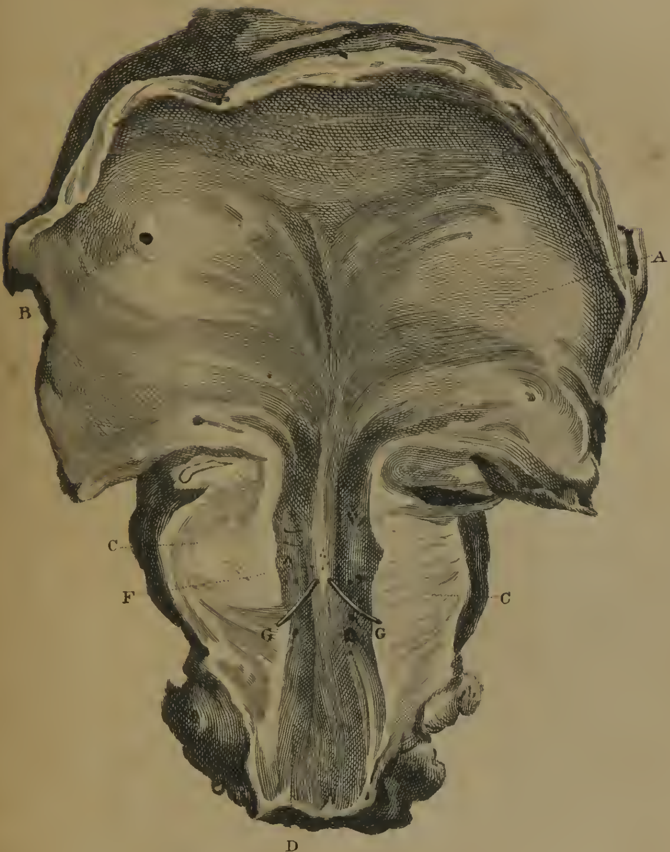

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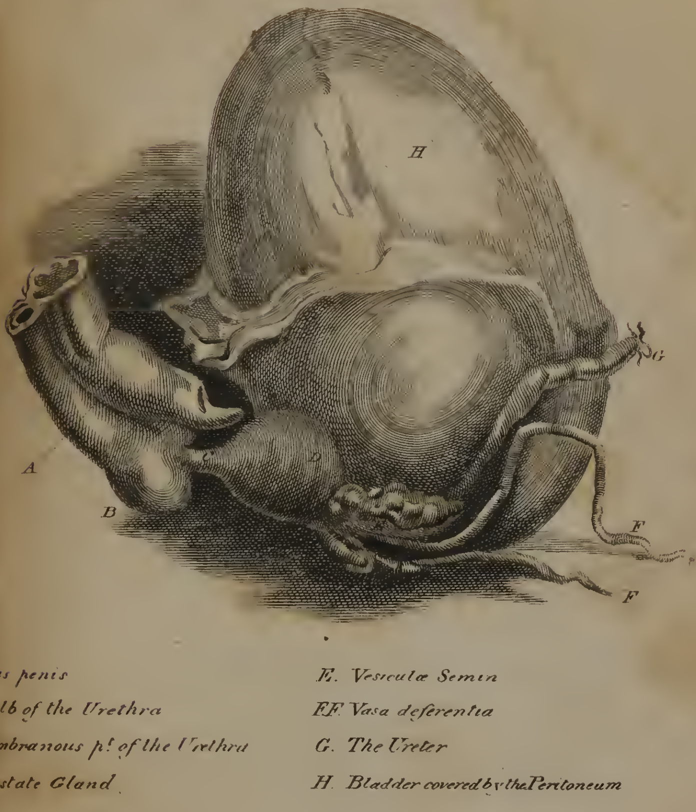

Crus penis
Bulb of the Urethra
Membranous p.t of the Urethra
Prostate Gland

E. Vesiculæ Semin
FF Vasa deferentia
G. The Ureter
H. Bladder covered by the Peritoneum

Lenny sc.t

C. The extremities of the ducts common to the vesiculæ seminales and vasa deferentia.
D D. The cells of the vesiculæ seminales, which are laid open by a section.
E. The left VAS DEFERENS, which is also laid open to shew the cellular structure which it assumes towards its termination.
F. The RIGHT VAS DEFERENS.
G G. The foramina, by which the vasa deferentia open into the common duct.
H. The lower and back part of the BLADDER.
I. The RIGHT URETER.

EXPLANATION OF PLATE IV.

This plate represents a section of the neck of the bladder.

A. The lower part of the urinary bladder near the neck.
B. The opening of the right ureter, which is marked 1 fig. iii.
C C. The substance of the prostate gland, which is cut through; its thickness, texture, and the manner in which it surrounds the beginning of the urethra, will be understood from this plate.
D. The URETHRA laid open.
F. The VERUMONTANUM, or CAPUT GALINAGINIS.
G G. The points of feathers put into the openings of the vesiculæ seminales and vasa deferentia.

N. B. Round these ducts, on the surface of the verumontanum, and in that part of the urethra which is surrounded by the prostate gland, innumerable mucous ducts may be observed: into some of these small bristles are introduced.

EXPLANATION

OF THE

PLATES.

PLATE VI.

Fig. 1.

AN ovum in a very early stage, representing the shaggy surface of the true chorion.

Fig. 2.

We may see here the fœtus in a very early stage contained in the transparent amnion, and, attached to the outside of the amnion, the VESICULA UMBILICALIS.

N. B. These are not representations of the same abortion.

Fig. 3.

Represents the ovum a little more advanced.

A. The Chorion.
B. The Amnion.
C. The Foetus hung by the Umbilical Chord.

Explanation of Plate VII.

This plate represents two views of a conception, we shall say about the end of the first month, and here the decidua and the ovum have been thrown off together. This abortion was prepared so as to resemble the beautiful engravings in Dr. Hunter's xxxiv table.

Fig. 1.

Fig: 2.

Fig: 3.

Lowry sc.

Bell del.t

Maverick sc

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FIG. 1.

The deciduous efflorescence formed by the womb is seen here entire, and seen as if moulded to the cavity of the womb: it is only necessary to observe that it hung inverted.

A. The lower part of the conception, which was near the neck of the womb, and which has some coagula of blood attached to it.

B. B. Quills introduced within the decidua by an opening near the neck of the womb, and their points brought out at that part of the membrane which answers to the opening of the Fallopian tubes: there it is either entirely deficient, or it is so thin that it has been torn at C. C.

FIG. 2.

Here the other side of the conception is shewn, and the ovum is seen to have adhered to the outer surface of the decidua.

AA. AA. The quills introduced into the cavity of the decidua.

B. The shaggy surface of the decidua.

C. C. The fleecy outer surface of the chorion.

It is here to be observed that the ovum, C D E. may be supposed to be as it has descended from the ovarium, only somewhat enlarged, and it is here evidently on the outside of the decidua, but it has been torn open, and that deciduous surface which connected it to the surface of the womb at this place has been left with the womb, to be afterwards thrown off with the discharges.

D. The delicate membrane the amnios.

E. The umbilical chord, and part of the fœtus.

EXPLANATION OF PLATE VIII.

This and the following plate represents a conception of the third month, and as the abortion was thrown off very entire, we have another opportunity of observing the state of the decidua in a more advanced state.

A. A thread passed through the more solid placentary mass suspending the whole.

B. B. The DECIDUA, having a peculiar reticulated appearance.

C. C. Shreads of the DECIDUA, where it has burst in the delivery.

D. The DECIDUA REFLEXA, through which also the proper membranes have burst.

E. The TRUE CHORION.

F. Very small curling arteries which are entering the decidua, or what may be considered as the maternal portion of the placenta.

Explanation of Plate IX.

We have here presented a view of a section of the same conception.

A. The DECIDUA.

B. B. The cut edge of the DECIDUA, which will be seen to surround the whole ovum, and particularly it may be observed to form on the upper part a distinct lamina from the placenta F.

C. C. The DECIDUA.

D. The DECIDUA REFLEXA.

F. The PLAÇENTA already formed by the accumulated vessels of the chorion.

G. The CHORION towards the lower part of the womb ; here, it may be observed the fleecy vessels have disappeared.

H. The AMNION.

I. The umbilical chord twisted three times around the neck of the fœtus.

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INTRODUCTION.

VIEW OF THE SYSTEM OF THE VISCERA, AND OF THE STRUCTURE OF GLANDS.

IN this last volume we have to comprehend the anatomy and functions of the several viscera of the abdomen and pelvis, considered not only as individual parts, but as connected together and as forming with the lymphatic and circulating systems of vessels a great part of that chain of mutual dependance and relation which constitutes the animal œconomy a whole. It becomes necessary therefore to take here a slight and cursory view of the œconomy of the intestinal canal and absorbing system, including at the same time something of the history of opinions regarding secretion and the structure of glands. It will be understood, that these introductory observations are meant only to combine the several parts, and to prevent that manner of description, which is necessary to accuracy and minuteness, from leading us to consider the several parts as distinct and insulated.

An animal body is never for a moment stationary: the remotest part is in action, and every point is suffering a perpetual change. From the first moment of our existence we have commenced a revolution: we, by slow degrees, advance in activity and strength, and ripen to maturity; but by a slow and as sure gradations we decline to feebleness and infirmities: and the more rapidly that animals advance in the first stage of their progress, so is the proportion of their decline.

But it is not in observing the changes of the animal body from youth to age that the operations of the œconomy are the most interesting. It is when we find the living body to consist of parts performing a variety of functions, and these connected and mutually dependant; when we see the circulating fluid throwing out fluid and solid secretions to build up and support the body, which is in incessant and daily decay.—

Again, our admiration is strongly excited when we observe the system to consist of fluids and solids, and the existence of the animal to depend upon the balance of their power; the fluids separating and combining in new affinities, and forming the various secretions; and the solids having action, and that action controlling the affinities and new combinations of the circulating fluids. We find that life subsists by the due action of solids and fluids; or that an incomprehensible influence in a living body is exerted on the latter, and that the chemist can never so combine the fluids out of the body as to imitate the changes produced in a living system of fluids and vessels.—Forgetting that animation is the essential character of living bodies, physiologists have too much endeavoured in every age to explain the phenomena of animated nature by illustrations drawn from mechanics, chemistry, or hydraulics.

In a body in which there is life there is a perpetual waste; first by secretions, which for particular purposes are thrown into the cavities, and afterwards carried out of the body entirely by the excretions of the kidney, the perspiration by the surface, the exhalation by the lungs, the secretions of the internal cavities as of the intestines. But more than this, there is a decomposition of the solids of the body which are carried into the circulating fluids, and finally dismissed from the system. Lastly, we cannot but observe, that even the powers of muscular motion, nay, the powers of the mind and of the senses, are exhausted by exercise, and renovated through the influence of the circulation. The continued action of a muscle is followed by feebleness, and the continued impression of the rays of light exhausts the retina, so that the object becomes first faint and then vanishes.

Since there is waste of the solids and fluids, and exhaustion of the energies of the system, so also must there be a source of supply, and means of renovating its action. Accordingly animals have appetites requiring the supply of food, and the call of hunger is controlled by the necessities of their system.—When food is received into the first passages, there is thrown out from the stomach a fluid which dissolves it, changes its properties, and is itself essentially altered. The work of assimilation is thus begun. As this converted fluid takes its course through the intestines, it is more and more changed; more assimilated to the nature of the peculiar fluids of the animal; and having still additional secretions united to it, particularly the bile, it is by these means separated from the grosser parts of the aliment. This fluid, which is now called chyle, is absorbed by a particular and appropriate system of vessels, which, from their conveying this white and milky-like fluid,

are called the lacteals. These lacteal vessels carry the chyle to the thoracic duct, the trunk of the absorbing system; but not directly; for the chyle is deposited in the mesenteric glands, from which it is again absorbed and carried forward. Or if we suppose these glands to be merely convoluted vessels, its flow is at least delayed, so that it is not at once thrown into the mass of circulating fluids.

We find then that the stomach performs digestion, and the spleen, we will venture to affirm, is subservient to it. The secretion of the liver we find to prepare the chyle for absorption, while at the same time it is the peculiar stimulus to the intestines. The pancreas pours out a fluid which tempers the acrid bile. The superior part of the intestinal canal absorbs the nutritious fluid or chyle, while the gross remains of the food move on to be deposited in the great intestines. The great intestines are not only receptacles, but form at the same time an extensive secreting surface useful in the œconomy, by throwing off the waste of the system.

The lacteal vessels, which take up the chyle, are but branches of the system of absorbents—which is a system consisting of two great divisions, the lacteals and lymphatics: the first receiving the nutritious fluids from the intestinal canal, and the latter being absorbents, taking up the fluids which have been thrown out upon the cavities and surfaces of the body; and we presume upon the solid parts of the body also. Thus the new fluids, rich in supplies, are mingled with those which are fraught with the waste and decomposition of the system.—The thoracic duct, the trunk of this system, conveys these fluids thus mingled together into the right side of the heart, where they are received into the vortex of the circulating red blood. These fluids, now agitated and wrought up with the blood in the cavities of the heart, are sent through the circulation of the lungs, and submitted to the influence of their action and the exposure to the atmospheric air.

When chyle is formed in the stomach and intestines, it is observed to consist of albumen, serum, globules, and salts: but the change which it may undergo by its reception into the lacteals, its being deposited in their glands, its mingling with the lymph, its agitation in the heart, have not been observed, though it is natural to suppose that by degrees it assimilates in its nature to that of the circulating blood, and does at last become perfectly similar by the operation of the lungs.

By the exposure of the circulating fluids to the atmosphere in the lungs a gas is absorbed, which becomes an active principle in the blood, and from the blood is communicated to the solids.

That the blood of an animal has properties which distinguish it from mere matter we readily allow; but to say that it possesses life is to use a term in which few will acquiesce. It possesses properties while circulating in the vessels distinct from those which it shews out of the body; and these do not depend on the agitation and incessant motion, nor on the degree of heat, nor on any similar circumstance, but apparently on some secret influence which the vessels exert over it. The analysis of the blood by the chemists holds out to us little hope of advancing in the knowledge of the œconomy of a living animal. Chemistry, when applied to the analysis of animal matter, leaves its devotees in a perplexity of knowledge and discoveries which have no end, and which point to no conclusion.

There are produced from the blood a variety of fluids by organs which are called glands, and the formation or separation of these fluids is secretion. But the solid parts of the body ought to be considered as secretions equally with the matter which flows from the ducts of glands. For there is formed and deposited from the blood, during the round of its circulation, bone to support the incumbent weight of the body; muscular fibre, to give it motion; as well as all the other variety of solids and fluids. The only difference betwixt these solid depositions from the blood and the glandular secretions is, that the former are still within the influence of the vascular system, and that they are decomposed and re-absorbed, conveyed again into the mass of circulating fluids before they can be finally expelled from the body.

The chemists have observed the division of animal bodies into solids and fluids, but the subdivisions of these are very inaccurate. The fluids they have distinguished into three classes; 1st, Recrementitious humours, which go to nourish and support the body: 2dly, The excrementitious fluids, which are carried out of the body by certain emunctuaries; and the 3d are of a compound nature, being partly recrementitious and partly excrementitious. We must observe, however, that the fluids enumerated under these heads shew it to be a very incorrect arrangement. The *first* division comprehends the fat, the marrow, the matter of internal perspiration, and the osseous juice. The *second* comprehends the fluids of insensible transpiration, the sweat, mucus, cerumen, urine, fœces. And the *last* division comprehends the saliva, the tears, the bile, the pancreatic juice, the gastric and the intestinal juice, the milk, and the seminal fluid. To attend to their arrangements of the solid parts of animals would be equally far from serving any useful end; for they have thrown together parts so discordant

in function and so unlike in structure that they can be of no use in a general view of the œconomy, and cannot in chemical analysis shew a uniform result*.

Perhaps all the correctness to which we can at present pretend is some such division as this. Besides forming the solid mass of the animal body, these secretions are drawn from the blood: fluids which are subservient to the assimilating of new matter to the system; fluids which are useful in preserving the mobility of parts; and, lastly, the secretions which convey away the waste and debris of the body, which is successively replaced by the opposition of new matter.

From this short view of the system we understand how incessantly the powers are spent in action, and the fluids exhausted by deposition and secretion, and how essential to life the functions of those parts are which act upon and assimilate the food. It is the consideration of these parts which forms the subject of the first section of the present volume. As in the consideration of these functions the structure of the glandular organs becomes a chief subject of inquiry, it will be natural at present to consider in a general way the opinions which have been entertained regarding the structure of glands.

The peculiar nature of that organization by which the several secretions are formed, has hitherto eluded absolute proof by experiment or dissection. It is imagined that there are some organs which do little more than separate the parts of the blood like to the exudation by exhaling arteries. But neither in the exhalent arteries nor in the simpler organs can I imagine a simple straining of the blood, but rather that the same principle influences all, and that the several varieties of secretion depend upon a modification of the action. It would appear that the fluids in circulation and the vessels containing them must reciprocally affect each other: we know that a change on the state of the circulating fluids will alter the nature of the glandular action, and an excitement of the gland will still more powerfully change the nature of the secretion; the active power of the solids appearing to be an agent which controls and directs the chemical affinities.

We are struck with the variety of form in the secreting organs. We see a simple surface pouring out its fluids; or a simple canal into which the arteries throw out the secretion. We find again the secreting vessels and their ducts convoluted and massed together forming proper glandular bodies; of which kind are the solid abdominal viscera.

When we dissect the glands we do not find them to have a

* See Fourcroy's Analyſis of Animal Subſtances.

similarity in structure. Thus the substance of the liver, the kidney, the testicle, &c. are quite unlike, and as their secretions are different so are their sympathies: the effect of disease upon them, and the consequences of medicine operating through the general circulation will be to attach to one individually, leaving the others in their accustomed action.—Glands are different not only in their outward form, their general appearance when cut into, and the manner of the connection of their parts, but also in a remarkable manner in the length, size, and form of their vessels and ducts.

In considering the opinions of physiologists or anatomists regarding glandular secretion, and the structure of glands, we find in the first instance that the old physicians contented themselves with saying that the glands or viscera possessed a peculiar power to select and separate the fluids from the blood. The next class had recourse to hypothesis: they spoke of the separation of certain parts by means of fermentation*, or by a kind of filtering through the pores or vessels of glands; that these pores allowed only particles of a particular size or figure to pass them†. It was opposed to this hypothesis, that the thinner fluids must have run through the organs destined for the grosser secretions. But when a theory such as this is received no argument nor proof seems necessary to overthrow it. Resting upon authority alone, it stood until it was overturned by the fashion of new doctrines: one equally puerile was raised upon its overthrow.

We observe, says the founder of this theory‡, that wet or oiled paper will only transmit fluid of that kind with which it is previously imbued, it will not transmit the oil when wetted, nor will the water make any impression on the paper when previously oiled. Upon these facts are to be raised a theory of secretion! Betwixt the secreting vessels and the ducts, in the peculiar tissue of which glandular structure consists, there is interposed a fluid of that particular kind which is required to be secreted, and when the blood is driven against this tissue so imbued, no fluid but of a nature resembling that already deposited can be transmitted. By this hypothesis they explained secretion, making it to depend on the attraction and repulsion of the particles of the blood by fluids previously secreted. We may surely leave this class of physiologists accounting for the original depositation of the fluids in the glands, without a wish to search with them into the mystery of glandular secre-

* Van Helmont. Vieussens, &c.
† Charleton, Descartes, Borelli, Verheyn, &c. &c.
‡ Winslow. Helvetius.

tion. Commentators on this theory, by taking into the system the action of the nerves, indicated that they did not altogether forget that the body was alive*.

Another set of physiologists attributed the whole effect of secretion to the velocity of the blood in the glands or secreting vessels† ; others, to the length and curves of the vessels, and their action upon the fluids. Again, others have been satisfied with the round assertion that the vital action was the essential cause of secretion. This, it ought to be understood, must be universally acquiesced in, while yet there may remain an inquiry as to the apparent structure of glands. Disappointed in obtaining an unexceptionable general theory of secretion, we are only enabled to conclude, that while a power exists in an animal body, directing its actions, perhaps both in the solids and fluids, and particularly in the mutual influence which they exert, the form, length, and activity of the vessels and ducts give occasion to the greater or less degree of intricacy in the operation of the principles upon which the secretion depends.

Let us then attend to the observations of the strict anatomists, and to the appearance which the GLANDULAR VISCERA present under the knife.

It is not perfectly clear what the older anatomists meant by the expression Parenchyma. It would appear however to have saved them the trouble of investigation, and all abstruse speculation. They meant flesh, yet not muscular substance, but such as the liver presents. This matter they seem to have conceived to be formed by the blood. Thus Highmore describes the liver to be formed of the blood of the umbilical vein: the opinion originally of Erasistratus.

Previous to the time of Malpighi it is fruitless to trace the opinions of anatomists regarding the structure of glands. He was the first who sought to throw light upon this obscure subject by anatomical investigation, and he made a more rapid progress than has been done by any man since his day. If we take into consideration the difficulties he had to encounter in a new field, and the prejudices of the learned with which he had to combat, his merits will be found greater than even those of Ruysch. The opinions of Malpighi were received by those who, forsaking the authorities of names, saw the importance of the study of anatomy. Ruysch himself gave credit to the opinions of Malpighi in the early part of his life. But Ruysch's more attentive observations being contradictory to those of Malpighi, his maturer judgment rejected that anatomist's

* Conor, Tentamen epiſtolare de Secretione.
† Boerhaave, Pitcarne, &c.

proofs, and with a boldness in which he was never remarkably deficient he invented a new theory, or at least alleged new facts, and swayed men's opinions with an absolute authority.

MALPIGHI was an Italian, and born near to Bologna. Whilst yet a young man, being sunk under the accumulation of family distress, absorbed in grief, and lost to the consideration of his interest, he received comfort and assistance from his master, who urged him to embrace the medical profession. His progress was rapid. After studying at Padua, he was called to fill one of the chairs in Bologna. He was then solicited by Ferdinand II., Duke of Tuscany, to be professor in the university of Pisa. Here he was associated with liberal men: and now only in his second professorship did he learn to despise the scholastic learning of the time, and betook himself to experiment as the only means by which philosophy could be raised from the oppressive barbarism of the schools. Malpighi and Borelli were associated; they dissected together; they suggested thoughts to each other; they doubted, and canvassed freely each other's opinions; and were to each other an excitement and encouragement to perseverance and industry. They were supported by government; popular in their teaching; while they collected round them the learned men of the time. This was the origin of the famous Academy del Cimento. Malpighi was, after this, professor in Messene, and died in the Quirinal palace at Rome of a stroke of the apoplexy*, after having been some time physician to Pope Innocent XII. Malpighi had many enemies, and even some of his colleagues were animated against him with a dishonourable jealousy. Many laughed at his studies and occupations, as frivolous and absurd. Something must be allowed for men who had laboured with diligence to become learned; for these, his opponents, had passed their lives in the study of the Arabian writers. With them studies were enforced which held science in subjection; studies which, in place of invigorating, served only to chill and paralyse exertion, and retard ingenious investigation. Even Borelli, but from other motives, opposed and censured some of the dissertations of Malpighi.

Malpighi has been considered as the inventor of this department of anatomy, which the French, curious in distinctions, have called the analytic method. He shewed the impropriety of the term Parenchyma, as applied to the substance of glands. He proved that the lungs, for example, (which they

* Two pounds of coagulated blood were found in the ventricles of his brain by Baglivi.

also called parenchymatous,) were not fleshy, and had no resemblance to the glandular viscera of the abdomen. He taught, that though glands are smooth on their outer surface, they consist of lobules connected by cellular membrane: and, upon a still more minute investigation, that they consist of innumerable little folicules or sacs; that these are interposed betwixt the arteries which convey the fluids and the excretory ducts going out from them; that the arteries, or the vasa afferentia, after ramifying and encircling these bodies, pierce them and secrete the particular fluids into them. On other occasions he describes these little glandular bodies as applied to the ramifications of the arteries, like fruit hanging by the branches of a tree.

Malpighi threw in his liquid injections; dissected and examined with the microscope; made careful observations and experiments on living animals; and lastly, attended in a particular manner to the phenomena of disease. By disease no doubt parts swell out and are magnified, and become distinct; but it is not a test of the natural structure, or implicitly to be trusted to.

Scheme of Malpighi's opinion.

Fig. 1.

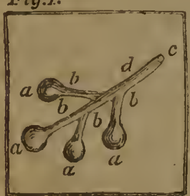


Fig. 2.

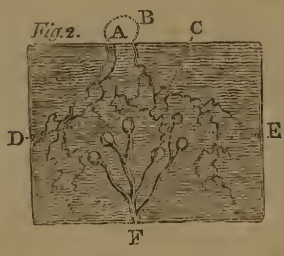


Fig. 1. Boerhaave's plan of Malpighi's doctrine. *a a a* folliculos glandularum simplicissimarum denotat. *b b b* singularia emissaria cuique utriculo *a*, propria atque in communem canalem excretorium *d*, *c*, suos humores demittentia qui tandem per hujus aperturam *c*, emittantur.

Fig. 2. is a scheme farther to elucidate the opinions of Malpighi. A, an artery entering a portion of a viscus. B, the returning veins. C, the branch of communication betwixt the artery and vein which serves to circulate the blood, and convey a part into the veins. D, another division of the artery, which after various playful meanderings terminates in

the folicule or little glandular bag E. F, the ducts which receive the secreted fluid from the folicules.

Ruysch studied at Leyden under Van Horne, and at a very early age attached himself to anatomy and botany. At this time he brought himself into notice by a defence of the professors against one Bilsius, who, although he was learned and acute, had attacked them with all the weapons of a Charlatan. Returning to his native country, he was raised to the professorship of anatomy and botany in Amsterdam. It was here that Ruysch made those discoveries in anatomy, and that wonderful and sudden progress in practical anatomy, which not only raised him above his cotemporaries, but has been the admiration of all since his time. Though new and various methods of preparing the body have been discovered since the time of Ruysch, yet there has been no approach to the elegance with which he displayed the structure of minute parts. It has been said that, while others preserved the horrid features of death, Ruysch preserved the human body in the softness and freshness of life, even to the expression of the features. We must no doubt ascribe some part of this encomium to the exaggeration naturally arising from the novelty of the thing. But as to his superiority in the manner of displaying the minute vessels of delicate parts, and his methods of preserving the parts in liquors, transparent and soft and so as to float in their natural folds, there can be no doubt.—Neither can the minuteness and success of his injections be denied: we have too many occasions in which we must resort to the catalogue of Ruysch's museum for the true anatomy, to doubt his great success, or to question the truth of those encomiums which have been bestowed upon him.

Kings, princes, ambassadors, and great generals, but more than these, all the learned men of the time, crouded to the museum of Ruysch. We must not blame him if, whilst others were merely speculating about the structure of parts, he, surrounded by so princely a museum, should simply have laid open his cabinets, and bid them satisfy themselves whether or not he was right. Ruysch's preparations went to contradict the opinions of Malpighi. His injections, pushed more minutely, showed those round bodies which are to be seen in some of the glandular viscera (and which Malpighi took to be little bags into which the secreted fluid was poured) to be merely convoluted arteries. Ruysch taught, that the minute arteries after making these convolutions terminated in the beginning of excretory ducts; that there was no substance or apparatus interposed, but that the vessels and ducts were continuous. His opinions being formed upon the strength of

more minute preparations, and a superior dexterity of anatomical investigation, few anatomists chose to be outdone, or to acknowledge that they could not see what he saw. This I believe to be one reason of the rapid progress of Ruysch's opinions.

Scheme of Ruysch's opinion.

1 1 The smaller arteries which do not enter into folicules, but are convoluted. 2 2 The appearance of bodies or bags, but which are merely owing to the convolutions and tortuous figure of the arteries before they terminate in the excretory ducts. 3 3 Excretory ducts or vessels formed by the continued extreme branches of the arteries*.

The opinions of Malpighi and Ruysch have held the schools in perpetual controversy; most anatomists however leaning to the authority of Ruysch. There follows these a crowd of French academicians, who, with Boerhaave, may be considered as mere commentators on the original authorities of Malpighi and Ruysch. Some of these argue for secretion by continuous vessels, and contend that the arteries terminate in the excretory ducts; others, that the secretions are made into folicules; and some, as Boerhaave, insist that both are right in their observations, and in the proofs which they have adduced, that secretion is in part performed by continuous vessels, partly by a more intricate glandular apparatus.

* Ruysch's doctrine again was thus opposed: Ruyschius auget arte sua replendi extensionem vasorum ultra naturalem magnitudinem. Ruyschius arte sua destruit glandulas; dein negat. Ruyschius negat omnes glandulas. Melius est & tutius omnia hæc demonstrare in cadavere recenti." F. Ruysch Epist. ad Vir. Clar. Her. Boerhaave, p. 50.

It may be farther observed, that it was not in the mere fact of there being folicules, in which Malpighi and Ruysch differed; for the latter conceded that there were hollow membranes, but contended that these were not glands. Their difference of opinion is expressed in the following words of Ruysch: "Adeoque discrepantia inter magnum illum virum et inter me est, quòd ille putat humores delabi in glandulas dictas simplicissimas,—ibi foveri, mutari: Ego puto, quòd arteriæ ultimæ succos faciant, & factos ibi deponant."

As the forms of the parts which throw out secretions have an infinite variety, it may be useful in this introductory view to point out these varieties, and their appropriate names.* In the first place, although in general language the term gland implies a secreting body, yet this does not follow from the definition of that word. According to Hippocrates, it is a tumid round body, soft, smooth, and shining. Many such bodies, and which we call glands, have no excretory ducts, and do not secrete a fluid; while most secreting parts admit of no such definition. When, again, we admit the definition of authors who have taught their peculiar opinions regarding their structure, we have a still less admissible description. Thus Malpighi defined a simple gland to be "Membrana cava cum emissario;" and Ruysch says, "Glandulæ nullæ componuntur ex sola membrana cava cum emissario, sed præcipue ex vasis."

These definitions of glands being optional and uncertain, it is necessary to use names appropriated to the several varieties of form in secreting parts. Indeed the term gland is inadmissible as conveying any knowledge of the minute parts of which the viscera are composed.

We must observe, however, that there is a division of glands still in use into *conglobate* and *conglomerate*. The first implies a gland simple in its form, the latter a gland having the appearance of an assemblage of several glands.† Now there is no gland that has not more or less the appearance which is described by conglomerated; that is, consisting of several parts, united by cellular membrane: and the distinction is attended with no advantage.

Acini form the last sub-division which we observe in the viscera, as in the liver; they are round bodies, not regularly invested with membranes, and which can be teased out into parcels of minute vessels.‡

Cryptæ are numerous in the body, We have an example of them in the great intestines.§ Crypta is a soft body, con-

* The terms acini, cotulæ, cryptæ, foliculi, glandulæ, lacunæ, loculi, utriculi, have been almoſt promiſcuouſly uſed; being ſo many names for bundles, bags, bottles, holes, and partitions.

† As the ſalivary glands and the pancreas. Farther, the lymphatic glands are generally called conglobate glands, being ſmooth and apparently ſimple in their ſtructure; but theſe, when injected, take exactly the appearance which ſhould naturally be deſcribed by the term conglomerate, conſiſting of many little cavities.—Theſe lymphatic glands belonging to a diſtinct ſyſtem, require no farther particular definition to diſtinguiſh them.

‡ See farther of the acini of the liver for example.

§ Ruyſch ad Virum Clar. H. Boerhaave, p. 53.

sisting of vessels not completely surrounded with a membrane, and resolvable by boiling or maceration.*

Folicules are little bags appended to the extremity of the ducts, into which the secretion is made, and from which it is evacuated by the ducts.

Lacunæ are little sacs opening largely into the passages, (as in the urethra,) and into which generally mucus is secreted; which, lodging there, is discharged when matter moves along the passage.

Finally, we have to recollect that every part of the body secretes; that every surface is a secreting surface; that even that surface which is produced by an incision no sooner ceases to bleed than a secretion begins. And that an ulcer in the skin or flesh becomes by habit similar to those organs, the peculiar functions of which is to secrete some matter useful in the system. This fact corrects the notions which we should otherwise be apt to receive of the action of secretion from contemplating the more complicated glandular organs.

* "Cryptarum vafcula poffum docere, fed funt tam fubtilia, ut reptatus non poffit diftingui; tantum circum affufa rubedo per repletionem videtur." Ruyfch ad Her. Boerhaave, p. 77.

PART THE FIRST.

OF THE ABDOMINAL VISCERA.

CHAP. I.

OF THE ABDOMEN IN GENERAL, AND OF THE PERITONEUM.

THE abdomen is that division of the body which is betwixt the thorax and pelvis. It is bounded above by the arch of the diaphragm ; behind, by the spine ; on the sides and fore part, by the abdominal muscles ; and, below, the abdominal viscera are supported by the alæ ilii and the pubis. The abdomen contains the viscera more or less immediately connected with digestion, and the kidneys which secrete the urine.

We speak of the cavity of the abdomen : but it is an inaccuracy of language ; for there is really no cavity : the parietes of the abdomen, viz. the abdominal muscles and peritoneum, closely embrace the contained viscera. To understand what is meant by the cavity of the abdomen ; to understand the connection of the several viscera, and the manner in which they lie contiguous, while they adhere at certain points only ; we must previously attend to the peritoneum. But, in the first place, let us notice the outward divisions of the belly.

OF THE REGIONS OF THE BELLY.

To give greater accuracy to the description of the seat of the viscera, or, perhaps rather, more strictly to connect the knowledge of the internal parts with the outward marks of the

belly, it has been long customary to mark certain arbitrary divisions on its surface, which are called regions.

The EPIGASTRIC REGION is the upper part of the belly, under the point of the sternum and in the angle made by the meeting of the cartilages of the ribs with the sternum. Upon the sides under the cartilages of the ribs are the HYPOCHONDRIAC REGIONS, or the right and left hypochondrium. These three regions make the upper division of the abdomen, in which are seated the stomach, liver, spleen, pancreas, duodenum, and part of the arch of the colon. The space surrounding the umbilicus, betwixt the epigastrium and a line drawn from the crest of one os ilii to the other, is the UMBILICAL REGION. The HYPOGASTRIC REGION is of course the lowest part of the belly, consisting of the angle betwixt the umbilical region, the spines of the ossa ilii and the pubis. The two lateral spaces betwixt the false ribs and the spine of the os ilii are the ILIAC REGIONS, or the LOINS.

OF THE PERITONEUM.

THE Peritoneum, like all the other membranes of the body, consists of an expansion of dense cellular membrane; yet it is what is called a proper or simple membrane; being a white firm thin contexture of cellular substance, in which no fibre or striated appearance is to be observed.* By its outer surface it adheres to the adipose membrane, on the inside of the abdominal muscles, and to the surface of the several viscera; its inner surface is smooth, and forms no adhesion while the parts are sound and healthy; its outer surface is looser in its texture, and by the splitting of its lamina it degenerates into the common cellular membrane.

The cellular membrane on the outside of the peritoneum is in some places short, firm, and dense; as on the liver, the spleen, the uterus, and the intestines: but it is longer, lax, and fatty, where it attaches the peritoneum to the muscles and tendons of the abdomen.

The peritoneum has no termination; or it is a sac; yet so curiously is it involved with the viscera, that though we say the viscera are contained in the abdomen, yet, accurately speaking, they are without the peritoneum, and consequently lie not in the abdominal cavity.†

The peritoneum is expanded on the lower surface of the

* The meaning of ſome anatomiſts, ſaying that the peritoneum is a double membrane, will be ſeen below.

† See Plate I. and the explanation.

diaphragm ; and at some of the interstices or perforations of that muscle or its tendon it comes in contact with the pleura, and adheres to it by cellular substance. From the diaphragm the peritoneum is reflected off to the liver, forming the ligaments of that viscus, and, expanded over its surface, it forms its outer membrane. From the diaphragm it is also sent off upon the œsophagus and stomach, and prolonged to the spleen on the left side (as it is to the liver on the right) so as to form the ligaments of the spleen.

The aorta, the great vena cava, the thoracic duct, and the kidneys, are behind the peritoneum ; that membrane being stretched before them. But the intestines are also in the same respect behind this general investing membrane : for it is merely reflected from the spine and psoas muscles, and from the great vessels running down upon the spine, so as to involve the intestines and form their outer coat. As it stretches towards the tract of the intestinal canal, it consequently involves the vessels of the intestines in its duplicature, and forms the mesentery.

The peritoneum also lines the abdominal muscles : it is reflected from the diaphragm upon the surface of the transversalis and rectus abdominis muscles. Here it is united to them by a loose adipose membrane, and from the abdominal muscles it is continued upon the inside of the pubes. From the pubes it ascends upon the bladder of urine ; descends again behind the bladder ; and there, making another reflection to mount over the rectum and form the meso-rectum, it leaves betwixt the rectum and bladder a particular sacculus.

From this detailed description we see that the peritoneum has no termination : that it is continued from the surface of the diaphragm to that of the abdominal muscles ; from that over the bladder and rectum ; from the rectum in the whole length of the intestinal canal ; and from the intestinal canal up upon the diaphragm. We see then what is meant when it is said that it is a shut sac ; we understand by the cavity of the peritoneum merely the inside of this sac ; and that when distended with fluid, that fluid is contained betwixt the peritoneum lining the abdominal muscles and that part of it which invests or forms the outer membrane or coat of the intestines.—This fluid, whether collected there by disease or thrown in by experiments, has no natural outlet, nor does it transude in the living body.*

* Soemmerring, Corp. Hum. Fab. Contemp. Peritonei, § iii.
We not unfrequently find an accurate general deſcription in authors, but ſome incorrectneſs in the ſubordinate detail ; which throws back the ideas of the reader into confuſion. Such is the enumeration of the holes or perforations of the perito-

BLOOD-VESSELS OF THE PERITONEUM.

As the peritoneum is a membrane of great extent, and investing a variety of parts, its vessels come from many sources. It receives arteries and veins from the mammary vessels; from the phrenic and epigastric vessels; from the lumbar arteries and veins; and from the ilio-lumbalis, circumflexa ilii, renal, and spermatic arteries. It receives nerves from the intercostal, lumbar, and diaphragmatic nerves.

It would appear that disease has given rise to the opinion that the peritoneum has in it many little glands. This is controverted decisively by Morgagni.

OF THE USE OF THE PERITONEUM.

The peritoneum serves as a dense and outer coat to the abdominal viscera; conveys the vessels to them, as in the example of the mesentery; and, having its inner surface smooth and lubricated by a watery secretion, it allows the parts to lie in contact (they being strongly compressed by the surrounding abdominal muscles and diaphragm,) and at the same time allows in the intestinal canal a capacity of motion without friction.

There is no internal surface or cavity, as it is called, of the living body, which is not moistened by an exudation from the vessels of the surface. Thus it is with the peritoneum. An exhalation from the extreme arteries bedews its surface, and is again taken up by absorbent vessels; so that it does not accumulate in health, nay even fluids poured into the abdominal cavity will be taken up by the absorbents.* When the abdomen is opened in animals alive, or recently killed, as in the shambles, a vapour is seen to exhale from the peritoneum

neum, " pour donner paſſage à l'œſophage, à la veine-cave," &c. See Anatom. Chirurg. par M. Palſin. We ſee that there are no ſuch perforations, that the œſophagus never enters into the cavity of the peritoneum, nor does the rectum paſs out from its cavity. This was indeed explained by Fernelius in oppoſition to Galen. See a deſcription of the inflections of the peritoneum by Bartholin.—Specimen Hiſtoriæ Anatomicæ Analect. Ob. I.

* See Nuck Sialograph. c. ii. p. 27.

Qua copia in ſtatu ſecundùm naturam ſecernatur dictu difficile eſt: ad uncias certe collecta aquula in ſani hominis abdomine reperitur. (Kaawn, 543.) In homine, cui ſponte abdomen ſub umbilico ruptum erat ad quinque & ſex libras de die effluebat. (Journ. de Med. 1757 M. Aug. ut denique 800 libr effluxerent.) This, however, proves nothing of the nature or quantity of the ſecretion; this has probably been an inflammation and abſceſs of the peritoneum, which, we have ſeen, pours out ſuch a quantity of fluid, thin and ſerous, as quickly to drop through the bed-clothes upon the floor.

having a peculiar animal odour. Yet we ought not to say that this vapour is collected in the dead body; for before the opening of the peritoneum, or the death of the animal, it is not in a state of vapour, but is condensed into a watery exudation*. I have seen, in the high state of inflammation of this membrane, pus formed upon the surface without ulceration, and therefore, probably, from the same exhaling or secreting surface; and coagulable lymph lying in flakes upon it. The increase of the serous discharge forms the common ascites; but whenever the natural secretion or exudation from the peritoneum is altered, adhesions are apt to form.

One great use of the peritoneum is to retain the viscera in their place, says Haller; for when it is wounded they escape, and sometimes with a sudden impetus, which makes it difficult to reduce or retain them†. But this is not from the want of the embracing of the peritoneum, but from the tendons or muscles which support the peritoneum being cut; for when there is a deficiency in the support given by the abdominal muscles, or their expanded tendons, the peritoneum does not prevent the viscera from being protruded, but easily yields to their forcible protrusion, and forms a sac involving this hernia.

Nor do the processes of the peritoneum, which have received the name of ligaments, nor the mesentery, nor mesocolon, sufficiently resist the prolapsus of the viscera when they have escaped from the pressure of the surrounding muscles. Sufficient example of this we have in hernia of the intestines, in which the mesentery is greatly elongated, or in the displacement of the stomach, or in the prolapsus and procedentia uteri.

The peritoneum which forms the sac of hernia retains little elasticity, and does not shrink into the belly when freed from the outer adhesions; but the general peritoneum will allow great distension, as in ascites, and quickly contract to its former dimensions on the evacuation of the fluid; and so that part of the membrane which invests the stomach and intestines the bladder of urine and gall bladder, has considerable elasticity, since it suffers these parts to be distended and again returns to its former dimensions.

The consideration of the insufficiency of the peritoneum to retain the viscera leads us to attend to a circumstance of the greatest importance connected with the viscera of the belly. The abdomen is every where (except towards the spine) sur-

* This vapour I have feen arifing from the inteftines of the human body during the operation for hernia; and alfo when the omentum and inteftines have efcaped in confequence of a wound of the belly.

† Element. Phyfiol. tom. ii. p. 380.

rounded by muscles. Above we see the diaphragm; before, and to the sides, the abdominal muscles; and even below, the parts in the pelvis are surrounded and compressed by the levator ani, in such a manner that the whole of the viscera suffer a continual pressure. This pressure upon the viscera appears to be uniform and constant, notwithstanding the alternate action of the abdominal muscles and diaphragm as muscles of respiration: but it must be occasionally very violent during exertions; in pulling, for example, or in straining, as a sailor must do in working of the great guns, or when pulling at the oar, or when balancing himself upon his belly over the yard-arm. And indeed by such violent and general compression of the viscera of the belly, ruptures are sometimes produced, of the worst kind, and followed by the immediate train of urgent symptoms.

The viscera having in general delicate outer coats, and no ligaments capable of supporting them, and being very vascular, require the support of this pressure of the surrounding muscles; and the great venous trunks which take their course through the abdomen are in a particular manner indebted to the pressure of the abdominal parietes. We must recollect also the bad consequences which result from the sudden relaxation of the abdomen; as in women after delivery, or in consequence of withdrawing the waters of ascites without due compression of the belly; languor, faintness, and even death, are sometimes produced, apparently by the balance of the vascular system being destroyed.

Some good authors in former times have described the peritoneum as a double membrane*. This was no farther a mistake than as they considered the cellular membrane, which lies without the peritoneum, as a part of it. It is necessary to recollect this in order to understand the meaning of their calling the sheath of the cellular membrane, which accompanies the vessels passing out from the abdomen, productions of the peritoneum. The vaginal productions of the peritoneum are the sheaths of the common cellular substance which accompany the aorta and œsophagus into the posterior mediastinum; or which give a bed to the spermatic vessels, or passing under Poupart's ligament accompany the vessels of the thigh. They are improperly termed productions of the peritoneum.

The proper productions or prolongations of the peritoneum are of a very different kind; they are the mesentery and omenta and ligaments: but, as I have explained in general how the mesentery and ligaments are formed by the peritone-

* See Anat. Chirurg. par M. Palfin, tom. II. p. 35. and note *a*

um, and as they must come presently to be considered more particularly, we treat no farther of them here*.

OF THE OMENTA.

The Omenta are considered as secondary processes of the peritoneum, because they are not formed by the peritoneum reflected off from the spine upon the intestines, as the mesentery is,—it being a primary process; but they are reflected from the surface of the stomach and intestines. Anatomists distinguish the omentum majus,—colico-gastricum: the omentum minus,—hepatico-gastricum; omentum colicum; and lastly, the appendices epiploïcæ.

The OMENTUM, OR EPIPLÖON, meaning thereby the great omentum, is a floating membrane of extreme delicacy, expanded over the surface of the small intestines, and attached to the great arch of the stomach and intestinum colon.—Although this membrane be of extreme delicacy and transparency in the young subject†, yet it is much loaded with fat, and appears transparent in the interstices only; and in advanced age it loses much of its delicacy, and acquires a degree of diseased consolidation or firmness, and is often irregularly collected into masses, or adheres preternaturally to some of the viscera.

The omentum majus hangs suspended from the cellular connection betwixt the arch of the stomach and the great transverse arch of the colon; or rather it forms that connection betwixt the stomach and colon. It consists of two membranes, or is as a sac collapsed and hanging from the stomach and colon‡, one of the sides being the peritoneum reflected off from the œsophagus and along all the great arch of the stomach, and the other that which comes from the arch of the colon. And further, as each of these lamina may be supposed to consist of two lamina; for example, where the omentum is formed by the meeting of the peritoneum from the lower and upper surfaces of the stomach; these two, meeting, form the upper lamina: and as, where the lower layer of the omentum comes off from the colon, it is also formed by the peritoneum

* See farther of the peritoneum under the head Mesentery, Mesocolon, Descent of the Testicle, &c.

† Præterea tenerrimas esse ut nulla membranarum humanarum, retina oculi excepta, æque sit tenera.

Haller, vol. vi. lib. 20. § 1. par. 12.

While its delicacy is remarkable in the young subject, the retiform vessels (vid. Ruysch. Ther. II. Q. V. Spegil. LVIII. &c.) have the fat accumulated in their tract as if it were thrown up by them to a side; but often the fat increasing obscures the vessels.

‡ Marsupium the common term.—See Winslow, IV. § 352.

reflected in the same manner; so with some truth the omentum is supposed to consist of four lamina of membranes of extreme tenuity: but these four layers cannot be demonstrated. The great omentum extends from the bosom of the spleen transversely, until it terminates on the right side of the arch of the colon, where the omentum colicum begins.

The great omentum varies considerably in extent. In a child it is short; in the adult further extended over the viscera: sometimes it reaches only to the umbilicus; sometimes it is allowed to extend its margin into the pelvis, so that in old people it is very apt to form a part of the contents of hernia: often it is wasted and shrunk; sometimes collected into masses leaving the surface of the intestines.

OF THE OMENTUM MINUS OR HEPATICO GASTRICUM.

This is a membrane of the nature of that last mentioned, but in general less loaded with fat. It is extended from the liver to the lesser arch of the stomach. It passes off from the lower surface of the liver at the transverse fossa; from the fossa ductus venosi; invests the lobulus spigellii; involves the branches of the cæliac artery; and is extended to the lesser curvature of the stomach and the upper part of the duodenum.*

OMENTUM COLICUM.

This is a continuation of the great omentum upon the right side of the great arch of the colon, where it rises from the caput coli; but it seldom extends its origin from the colon the length of the caput coli. It can be inflated like the great omentum.

APPENDICES EPIPLOICÆ, OR OMENTULA INTESTINI CRASSI.

These are little fatty and membranous processes which hang pendulous from the surface of the colon: they are of the same texture and use with the greater omentum and right colic omentum.

We have mentioned that the omenta are double reflections from the peritoneum, and consequently they may be inflated so as to demonstrate them to be perfect sacs. To do this it is not

* "Macilentius eſt, et vaſa habet minora." Winſlow. Haller. Indeed it ſeems rather to anſwer the general purpoſe of a cellular membrane conveying veſſels, than the purpoſes of the omentum majus.

required to puncture any part of them, for there is a natural opening by which the whole may be inflated in a young subject, and in a healthy state of the viscera.

This natural opening into the purse or sac of the omentum is betwixt the membrane involving the vessels and ducts of the liver, and the peritoneum, where it invests the vena cava betwixt the neck of the gall bladder and the first turn of the duodenum, or where the lobulus caudatus hepatis touches the duodenum. By introducing a blow pipe into this natural fissure the foramen of Winslow, the omentum minus may be raised: the gastro colic, and colic omenta may be inflated. This opening serves as a communication betwixt the cavities of the omentum and the general peritoneal cavity; but I am inclined to think it is very frequently destroyed by adhesion.* As this opening points towards the right side, Dr. Monro thinks it a sufficient reason for introducing the trochar on the right side in the operation of tapping for ascites, (contrary to the usual caution of avoiding the liver, which is so often diseased in this case,) and that by operating on the left side he thinks the water will not be allowed to flow from the sac of the omentum.† It appears to me that it will flow equally well from whatever point of the belly the water is drawn.

There is a considerable variety in the form of the omentum of animals,‡ but still they seem to shew the same provision of involving the intestines, filling up the inequalities which arise from the rounded forms of the viscera, and still further lubricating and giving mobility to the intestines.§ The surface of the omentum, however, seems merely to furnish a fluid exudation like the general surface of the peritoneum; at least the idea which has been entertained of the oil or fat exuding is quite improbable.||

The use assigned to the omentum of being subservient to the function of the liver is deservedly neglected.¶

* Winflow, Duverney, and Haller.

† *Quer.* If I fhould fay to a patient, by punćturing here I am in danger of thrufting this inftrument into your liver; by introducing it here there is lefs poffibility of any fuch accident, though I may not draw off all the water; what would be her anfwer?

‡ Haller Element. Phyfiol. tom. vi. lib. xx. § 2 and 3.

§ We muft not fuppofe that becaufe a mad man ftabs himfelf in the belly, and there is afterwards found coalition of the inteftines to the wounds, the omentum has not done its office, (fee Boerhaavii Prelećtiones, vol. i. § 45.) no more can we give credit to the tale told by Galen (De Ufu Partium, l. iv. c. 9.) of the gladiator who loft part of the omentum, and ever after had a coldnefs in his guts! at leaft we cut out a great part of the omentum from a man without any fuch fenfation being the confequence now-a-days.

|| "Et dum halitu pingui & ipfa obungit & peritoneum." Hale loc. cit. Boerhaave, &c.

¶ Viz. by fupplying a grofs oily matter to the venæ portæ.

CHAP. II.

OF THE MEMBRANEOUS VISCERA OF THE ABDOMEN.*

HAVING understood the nature of the general investing membrane of the abdomen, and what is meant by its cavity and its processes, we take a general survey of the œconomy of the viscera, before entering upon the minute structure of the parts individually.

The organs destined to receive the food, and to perform the first of those changes upon it which fit it (after a due succession of actions) for becoming a component part of the living body, are the stomach and intestines primarily; the glandular viscera, the liver, pancreas, (and in all likelihood the spleen,) as subservient or secondary organs. I have been accustomed in my lectures to divide these parts into the membranous or floating viscera, (viz. the whole track of the intestinal canal) and the glandular viscera; or perhaps, what is still better, they may be distinguished into those parts which have action and motion, and those which are quiescent or possessed of no power of contraction. Thus the stomach, intestines, gall-bladder, and bladder of urine (though this belongs to the pelvis) have muscular coats, and the power of contracting their cavities; while the liver, spleen, pancreas, and kidnies, have no muscularity but in their vessels and excretory ducts.

This division of the viscera may lead to important distinctions in pathology. During inflammation, it is observed, that though the parts possessing a power of contraction may sometimes lie inactive without pain, yet in those parts when roused to action there is excruciating pain. On the other hand, it often happens that the glandular and solid viscera are the seat of long continued disease, which is attended only with a dull or low degree of pain; while the anatomist is often struck upon examining the body after death with the wide ravages of the disease.

We divide the intestinal canal into three parts; the stomach, the small intestines, the great intestines. The small intestines are subdivided into the duodenum, jejunum, and ileon. The

* Although the term Viſcus implies more particularly the fleſhy or ſolid contents as the heart, liver, kidnies, yet we uſe it in general for all the parts contained in the great cavities.

great intestines are subdivided into the cæcum, colon, and rectum. The stomach is the seat of the digestive process: in the duodenum the food receives the addition of the secretions from the liver and pancreas, and is still further adapted to animalization; in the long tract of the jejunum and ileon the nutricious part is absorbed; and in the great intestines the effete matters are carried slowly forward, and at the same time suffer a further absorption of their fluid contents, until as fœces they lodge in the rectum or last division of the canal.

From this view it is apparent that as each division of the intestinal canal is marked by some peculiarity in its use or function, we must carefully examine their minute structure as individual parts, at the same time that we do not allow ourselves to forget the universal connection, the integrity of the circle of actions, and the œconomy as a whole. With this intention, following the course of the food, and with a view also to connect the present subject with the last part of vol. iii. we treat first of the œsophagus.

SECTION I.

OF THE ŒSOPHAGUS.

The œsophagus or gullet is a cylindrical tube, partly membranous and partly fleshy; which is continued from the pharynx down behind the larynx and trachea and close before the spine. Still continuing its course in the back part of the thorax, it perforates the diaphragm, and expands into the upper orifice of the stomach; its use is to convey the food by deglutition into the stomach.

Although with many authors I call it a cylindrical tube, and it may take this form when dissected from the body and inflated, yet during life it lies collapsed with its inner membrane in close contact, and it transmits the morsel only by the continued succession of the contraction of its fleshy coat.

The upper part of this tube is called the pharynx. It may be described as expanding funnel-like, and is attached to the occipital bone, pterygoid processes of the sphenoid bone, and jaw bones; and further down it is kept expanded upon the horns or processes of the os hyoidis. This bag is very fleshy, being surrounded with muscular fibres, which take their origin

from the neighbouring points of bone; as the styloid process, the horns of the os hyoidis, the thyroid cartilage;* by which it is enabled to grasp and contract upon the morsel when it has been thrust by the tongue behind the isthmus faucium. This strong tissue of muscular fibres which surrounds the pharynx, is continued down upon the œsophagus in the form of a sheath, which has been called vaginalis tunica.

STRUCTURE OF THE ŒSOPHAGUS.

I BELIEVE we can with propriety enumerate no more than two proper coats of the œsophagus; its muscular and internal coat; for that which is sometimes considered as the outer coat, is only the adventitious cellular membrane, and the nervous coat is merely cellular tissue connecting the muscular and inner coat.

The MUSCULAR COAT of the œsophagus greatly surpasses in strength and in the coarseness of its fibres any part of the whole tract of the intestinal canal. There may be very distinctly observed in it two layers of fibres; an external one consisting of strong longitudinal fibres, and an internal one of circular fibres. These lamina of fibres are more easily separated from each other than those in any other part of the body.† But an idea is entertained that the one set of fibres, the circular and internal ones, are for contracting the tube, and the outer ones for elongating and relaxing it. I believe on the other hand that they contract together, conducing to one end, deglutition.‡

What is called the TUNICA NERVEA is the cellular connection betwixt the muscular and inner coat, and is very lax, insomuch that the muscular coat and the inner coat are like two distinct tubes, the one contained within the other, and but slightly attached. This appearance is presented particularly when the œsophagus is cut across.

The INNER COAT of the œsophagus is soft; glandular villi are described as being distinguishable on its surface, and it is invested with a very delicate cuticle to dull the acute sensibility, and prevent pain in swallowing. It in every respect re-

* See vol. i. p. 141.

† It appears that the œſophagus can be ruptured in two ways: acroſs, by the tearing of the longitudinal fibres; and longitudinally, by the ſeparation of the longitudinal fibres. This, though a rare accident, takes place in violent vomiting or ſtraining to vomit; and, in the firſt inſtance, the tearing acroſs of the œſophagus ſeems to be the effect of the action of the diaphragm on the œſophagus. By this accident the fluids of the ſtomach are poured into the cavity of the thorax.

‡ See farther of the muſcular coat of the inteſtines. "It was at one time ſuppoſed that the muſcular fibres of the œſophagus had a ſpiral direction." See Verheyen, and Morgan. Adverſar. iii.

sembles the lining membrane of the mouth. The power, however, which the œsophagus seems to possess of resisting heat depends not on the insensibility bestowed by the cuticle, but is owing to the rapid descent of the hot solids or liquids swallowed; for when they happen to be detained in the gullet they produce a very intolerable pain. This inner coat has an exhaling surface, like the rest of the body, with particular glands to secrete and pour out that mucus which lubricates the passage for the food*. The inner coat is capable of a great degree of distention, but it is not very elastic, or at least contraction of the muscular coat throws it into longitudinal folds or plicæ†.

In the neck, the œsophagus lying betwixt the cervical vertebræ and the trachea, is at the same time in a small degree towards the left side. In the thorax it runs down betwixt the pleura of either side, where they form the posterior mediastinum. Here, even when it descends upon the dorsal vertebræ, the œsophagus lies rather to the left side; it then passes under the arch of the aorta, but quickly escapes from under its compression and rises on the right side of the aorta, and as it passes further down it gets more and more before the aorta. This is sufficiently apparent when we attend to the relation of the perforations in the diaphragm for transmitting the aorta and the œsophagus.

Behind the œsophagus, in the thorax, there are one or two lymphatic glands, which were understood by Vesalius to belong to the œsophagus. What deceived him is an appearance generally to be observed in these glands. The lymphatics, or the small branches of veins, are generally filled with a black matter, which, extending to the coats of the œsophagus, resemble very much the ducts of the glands going to open into the œsophagus‡.

The inner coat of the œsophagus shows so very different a texture from that of the stomach, and this difference is marked by so very abrupt a line, as sufficiently to indicate that the

* Thefe glands fuffer ulceration and fchirrous hardening, and are a terrible caufe of difficulty of fwallowing.

† Some part of the food lodging in the natural lacunæ of the œfophagus, or fome folid body, as the ftone of fruit being received into them, has been the caufe of a fac forming in the pharynx or œfophagus. And it has happened that fuch a fac, gradually and for years enlarging, has formed a bag, into which nearly the whole food, that fhould have paffed into the ftomach, was received, fo as to opprefs the œfophagus and occafion a lingering death. An example of this is to be feen in my mufeum.

‡ Thefe glands in the pofterior mediaftinum are fometimes difeafed, and enlarged fo as to comprefs the œfophagus and to caufe fo permanent an obftruction of deglutition as to kill.

fluids poured out from the œsophagus are very distinct from those of the stomach, and have no power of digestion.

SECTION II.

OF THE STOMACH.

Seat, Form, Displacement of the Stomach.

THE stomach lies under the margin of the ribs of the left side, and chiefly in the left hypochondrium. Its greater extremity is on the left side, in contact with the diaphragm; but towards the right, the shelving edge of the horizontal lobe of the liver is betwixt it and the diaphragm. On the lower part it is, by the mesocolon and arch of the colon, divided from the small intestines; and to the greater extremity the spleen is attached by vessels and by the loose intertexture of the omentum. The stomach may be said to be a conical sac; the extremities of which being made to approach each other, gives it the curve of a hunter's horn, and gives occasion to the anatomist, in strict description, to remark these parts; the SUPERIOR OI CARDIAC orifice into which the œsophagus expands; the LOWER OR PYLORIC orifice, which leads into the duodenum: the LESSER AND GREATER CURVATURES of the stomach.

The lesser curvature of the stomach extends from betwixt the two orifices; includes in its embrace the spine, the aorta, and the small central lobe of the liver, while there is attached to it the lesser omentum. The greater curvature of the stomach is the outline of its distended belly, which rises above the arch of the colon, and is marked by the course of the gastro-epiploic vessels.

When the stomach is distended the lower orifice is nearly on a level with the upper one; but when the stomach is allowed to subside, it falls considerably lower; so that whilst the stomach is lying across the abdomen it is also tending obliquely downwards. The ensiform cartilage will be found to present commonly to the middle of the stomach; and the lower orifice, when in its natural situation, is opposite to the fossa umbilicalis of the liver: the upper orifice is kept constantly in one place from the stricter connection of the œsophagus with the diaphragm.

Both orifices of the stomach present backward, especially

the upper one, while the lower one is pointed backward and downward. By the distention of the stomach the great arch is extended, the orifices are directed more backward and towards each other, and especially the greater extremity draws upon the œsophagus. By these means I conceive that there is sometimes produced a difficulty of the stomach discharging its contents when greatly distended, the orifices being in a great measure turned from the œsophagus and duodenum.

The stomach being liable to frequent varieties in its degree of distention, the natural relation of parts must frequently be altered. It ought to be particularly recollected, that in the living body the stomach is supported and bound up by the intestines; so that the great curve presents: and the broad anterior surface which the stomach presents in the dead body is turned directly upward, and the inferior downward*. By the collapsing of the stomach and the consequent falling down of the liver some have explained the sensation of hunger, conceiving that the uneasy sensation proceeds from the liver being allowed to hang upon the broad ligament†. From the great simplicity of mechanical explanation physicians have eagerly indulged in them, but it will in general be found that when they are applied to the explanation of the phenomena of a living body they are inadmissable.

OF THE COATS OF THE STOMACH.

The coats or membranes forming the stomach are, the outer, the muscular, the nervous, the villous, and the three cellular coats. For these subdivisions, however, I see no use, nor are they authorised by the natural appearance of the coats of the stomach. When there is a distinction in texture, structure, or function, and where these lamina can be separated, we should consider them as coats; but a mere intermediate tissue of vessels, or the connecting cellular membrane, are improperly considered as distinct tunics.

First coat.—From what has been already said of the peritoneum, it will readily be allowed that the outer coat of the stomach is formed by the peritoneum; a coat common to all the intestines. Were this not sufficiently evident in itself, it might be ascertained by dissecting the peritoneum from the cardiac orifice of the stomach, where it will be found reflected from the diaphragm. This coat is firm, simple in its texture,

* Thus the gastro-epiploic artery presents directly forward. It has been wounded, and bled both into the stomach and outwardly. I should conceive it possible in such a case to tie the artery.

† Winslow.

having no apparent fibrous texture, and smooth on its outer surface, with many minute vessels. Under the peritoneal coat is the first cellular coat, being in fact a short cellular tissue betwixt the peritoneal coat and the muscular coat.

MUSCULAR COAT.—The muscular coat of the stomach consists chiefly of two lamina of fibres; less distinct however than those of the œsophagus, or, in other words, more closely and irregularly connected. One set of fibres runs longitudinally, that is, from the one orifice to the other; the other set runs encircling the stomach; yet there are such irregularities that it is difficult in every place to recognize the two great and original divisions of fibres; and on this account in general three strata or series of fibres are described.* For an example of this apparent irregularity, there comes down upon the flat side of the stomach an irregular fasciculus of fibres, apparently from the longitudinal fibres of the cardiac orifice, and continued from those of the œsophagus, which yet take a course fairly encircling the stomach. They cannot be strictly said to belong to either the circular or longitudinal series, and in many places those which run longitudinally on the stomach seem to sink and lose themselves amongst the lower fibres, or are reflected into transverse fibres.

These muscular fibres of the stomach do not run in an uninterrupted course, but split, rejoin, and form a kind of retiform texture through which the coats beneath are at intervals discernible. This structure would appear to bestow a greater power of contraction on the stomach. The strong longitudinal fibres which are seen upon the œsophagus form the outer stratum of the muscular coat of the stomach, and they extend from the œsophagus and cardiac orifice in a stellated form alongst the upper curvature, and downward upon the great end or sacculus ventriculi. Then we have to observe a set of circular fibres, which forming rings upon the great end, extend over all the stomach, like the circular fibres of the arteries. These fibres do not each encircle the stomach entirely, but while their general direction is circular, they are so interwoven that no one fasciculus can be followed to a great extent. These are called the TRANSVERSE FIBRES OF STRATUM; while the deepest stratum consists of the continued circular fibres of the œsophagus. These last fibres are strong upon the cardiac orifice, and may be presumed to form a kind of sphincter; but they diminish as they are remote from the superior orifice.

* The moſt general opinion is, that there are three layers of fibres in the ſtomach. Some deſcribe an external longitudinal ſeries; a middle tranſverſe ſtratum; and again the internal fibres running longitudinally. See Gal.ati Acad. de Bologne.

The lower or pyloric orifice of the stomach, however, is more carefully guarded by muscular fibres; having in the duplicature of the inner coats a distinct circular ring of muscular fibres.

The cellular tissue, being intermingled with the muscular fibres, connects and strengthens them, and gives the appearance of little white lines interwoven with the muscular fibres, and which some have described as small tendons.* There is also to be observed a broad ligamentous band on the two flat surfaces of the stomach towards the pylorus. They are like the bands of the colon, but not nearly so strong or evident.—They are formed by the denser nature of the cellular tissue, and more intimate union betwixt the first and second coats.

OF THE ACTION OF THE MUSCULAR COAT.

Upon considering the weakness of the muscular fibres of the stomach, and the membranous nature of the whole coats, it appears that the general action of the stomach is slow, regular, and by no means a forcible contraction; not an apparatus for triturating the food, but merely giving motion to its contents. But regarding the extreme sensibility of the stomach, and the gradual and regular succession of action, much will be found that is worthy of attention. It should seem that the morsel is sent down into the œsophagus by a succession of actions, preceded by a perfect relaxation; and that when the food arrives at the superior orifice of the stomach, by the same relaxation preceding the contraction, the muscular fibres of the upper part of the stomach yield and receive the food compressed by the œsophagus. Attending to the form of the stomach, we see a provision for the reception of the food into the great sacculated fundus on the left extremity. And here we shall find that there is a greater profusion of vessels for the secretion of the juices of the stomach, and a set of muscular fibres, probably relaxing and yielding to receive the food, and excited to action only when the process of digestion has been in part or entirely accomplished. We have proof that when the food has remained the usual time in the stomach, and comes in succession to be presented at the lower orifice, if the stomach is healthy and the change upon the food perfect, the lower orifice is relaxed, and yields to the contraction of the muscular fibres of the stomach, and the contents of the stomach are passed into the duodenum: but if the food has been of an indigestible nature, it is rejected. The pyloric fibres refuse the necessary relaxation, and by the

* See Winslow, sect. viii. p. 57.

unnatural excitement an antiperistaltic motion is produced, and the matter is again thrown into the great end of the stomach, or rejected by vomiting. There is in the natural action of the stomach a stimulus, followed by a regular succession of motion in its fibres, conveying the contents from the upper to the lower orifice of the stomach. Of this excitement and action we are not conscious ; but when the action is disordered by an unusual excitement, the lower orifice is not unlocked, the action becomes violent (the reverse of what naturally takes place,) and pain or uneasy feelings are produced. Upon this principle may be explained the nausea and vomiting which take place at certain times after eating, when balls or concretions are lodged in the stomach. While the food lies in the greater extremity, or in the body of the stomach, and the ball or concretion with it, there is no great excitement ; but when it has suffered the necessary change, and is approaching to the pyloric orifice, this part, being as it were a guard upon the intestines, is suddenly excited, vomiting is produced, and the ball is thrown into its old place in the sacculus or great end.

This great sensibility, producing effects almost like intelligence, is apparent in the more common disorders of the stomach. We shall find the meteorismus ventriculi (the great distension of the stomach by flatus) existing for weeks, and yet the food passing in regular course through its orifices.—We shall find very frequently food of difficult digestion laying in the stomach and oppressing its functions for days, while food more recently received may have undergone the actual changes, and have passed through the pylorus into the duodenum.

Owing to the same slow and successive action of the stomach, it often happens that ulceration and schirrus pylorus, or other obstruction of the lower orifice of the stomach, is attended with pain, nausea, and vomiting, only at stated intervals after taking food ; *i. e.* at the time in which the food should be sent into the intestines in the natural course of action.

The muscular fibres of the stomach are excited by stimuli, applied, not to their substance, but to the contiguous coats ; and betwixt the delicate surface of the inner coat and thè muscular fibres there is the strictest sympathy and connection.—The same connection holds in a less intimate degree betwixt the outer coat and the muscular fibres ; for when a part on the surface of the stomach of a living animal is touched with acid or stimulating fluids, the part contracts.* The stomach is con-

* " In ea ſede quà tangitur, contrahitur, ſulcuſque profundus naſcitur, et rugæ; cibuſque aliquando propellitur ut à ſede contracta fugiat. Minùs tamen quàm inteſtina ventriculus irritabilis eſt ; hinc emetica fortiora neceſſe eſt purgantibus."—Haller.

sidered as less irritable than the intestines, because it is alledged that a stronger dose of a medicine is required to prove emetic than to act as a purgative: but we ought to consider that the action thus excited in the intestines is merely an acceleration of their secretions; but vomiting is the interruption of the usual action, requiring such a violent excitement as to invert the natural action.

But there is something more than this; as the function of the stomach differs from that of the intestines, so may the quickness of their action. Thus in the stomach a gradual change is to be produced upon the food, requiring time and a slow degree of motion; but in the intestines there is a greater agitation of their contents, and a quicker action of their coats, to bring the fluids into more general contact with the absorbing surface, and to give greater activity probably to the absorption by the lacteals. I am inclined to think that the stomach is the most irritable part of the body, and susceptible of the most minute distinctions in the nature of the stimuli applied to it.—The phenomena of the living animal, and experiments in those recently killed, sufficiently prove the contractile powers of the two orifices. Experiments have been made which shew the powers both of the cardiac and of the pyloric orifices in retaining the contents of the stomach after the œsophagus and duodenum have been cut across. The stomach of a rabbit has been squeezed in the hand after cutting the duodenum, without any of its contents having escaped;* and in similar experiments, the finger being introduced into the lower orifice of the stomach of an animal yet warm, the fibres of the pylorus were found to contract strongly upon it. Upon forcibly compressing the stomach, the food will be made to pass into the œsophagus much more readily than into the duodenum; which is another proof how necessary the natural series of actions is to the relaxation of the pylorus.

Of vomiting.—When there is an unusual or unnatural irritation on the stomach, or when it is violently stimulated or opposed in its natural course of action, the motion becomes inverted; and drawing by sympathy other muscles to its aid, the contents of the stomach are evacuated by vomiting. Thus where the food takes changes inconsistent with healthy digestion; or when solid matters lodge in the stomach; or when secretions of the duodenum pass into the stomach, or unusual actions are propagated backwards upon the stomach from the upper portion of the canal; or when emetics are taken, which are unusual stimuli; or when there is inflammation in the sto-

* See a paper in the 3d vol. of Sandifort, Thes.

mach, which, from giving greater sensibility, produces the same effect with more violent stimuli; or when the coats are corroded or ulcerated;—vomiting is produced. That vomiting may be produced by the inverted motion of the stomach and œsophagus alone, is apparent from experiments upon living animals, where the abdominal muscles are laid open, and from cases in which the stomach has lain in the thorax, and yet been excited to active vomiting.* Again, it is equally evident that, when the stomach is excited to vomiting, there is consent of the abdominal muscles, by which they are brought into violent and spasmodic action; not alternating in their action, as in the motion of respiration, but acting synchronously, so as greatly to assist in compressing the stomach: but at the same time, the action of these muscles, however forcible their contraction, cannot alone cause vomiting; nor has this action any tendency to produce such an effect on other occasions in which the utmost contraction of the diaphragm and abdominal muscles is required to the compression of the viscera. Many have conceived that vomiting is entirely the effect of the action of the abdominal muscles and diaphragm. Such, for example, has been the opinion not only of J. Hunter, but of Duverney, and of M. Chirac in Hist. de l'Acad. des Sciences, 1700. M. Littre opposed this notion, and contended before the Academy, that the contraction of the diaphragm was the principal cause of vomiting. M. Lieutaud in 1752 supported the idea that vomiting is the effect of the action of the stomach. He found, upon dissection, in a patient whose stomach had resisted every kind of emetic, that it was greatly distended and become insensible; and concluded that the want of action in the stomach, and consequent loss of the power of vomiting, was a strong proof of the action being the effect of the contraction of the stomach only. There are other more curious instances of disease of the stomach preventing the muscular contraction in any violent degree, and consequently the absence of the usual symptom of vomiting:—an instance of this kind will be seen in Dr. Stark's work. In my Museum, Surgeons' Square, there is a preparation of a stomach, in which the walls had become so thick that they could no longer suffer contraction by the muscular fibres; the consequence of which was that, although the inner coat of the stomach was in a raw and ulcerated state, there was no active vomiting.

The singultus seems the partial exertion of the sympathy betwixt the upper orifice of the stomach and the diaphragm, by which a kind of weak spasmodic action is excited in it, but

* See Wepfer de Cicuta Aquatica, p. 68.—Sauvage's Vomitus.

without a concomitant inverted action in the stomach and œsophagus. It is a convulsive and sonorous inspiration, owing to an irritation of the upper orifice of the stomach and œsophagus, but not exactly of that kind which causes inversion of the natural actions of the stomach. Thus we have the hoquet des gloutons, the singultus, from some medicines and poisons, from some crude aliment, or even from some foreign body sticking low in the œsophagus, or from inflammation. The borborygmi and rumination seem to be gentler inverted actions of the upper orifice of the stomach and œsophagus, unassisted by any great degree of compression of the stomach by the abdominal muscles and diaphragm.

The full action of vomiting is preceded by inspiration, which seems a provision against the violent excitement of the glottis, and the danger of suffocation from the acrid matter of the stomach entering the wind-pipe ; for by this means the expiration and convulsive cough accompanying or immediately following the action of vomiting, frees the larynx from the ejected matter of the stomach. But the action of the diaphragm is farther useful by acting upon the mediastinum, which embraces the œsophagus, and no doubt supports it in this violent action.

NERVOUS OR VASCULAR COAT OF THE STOMACH.

What Haller calls the nervous coat, is the cellular structure in which the vessels and nerves of the stomach ramify and divide into that degree of minuteness which prepares them for passing into the innermost or villous coat. It may with equal propriety be called the nervous, the vascular, or the great cellular coat.* Taking it as the third distinct coat of the stomach, it is connected with the muscular coat by the SECOND CELLULAR coat, and with the villous coat by the THIRD CELLULAR coat. Strictly, however, it is the same cellular membrane, taking here a looser texture to allow of the free interchange and ramification of vessels. When macerated, it swells and becomes like fine cotton, but has firmer and aponeurotic-like filaments intersecting it, and it can be blown up so as to demonstrate its cellular structure.† It is in this coat that anatomists have found small glandular bodies lodged, especially towards the extremities or orifices of the stomach.

Villous coat.—This is the inner coat, in which the vessels are finally distributed and organized to their particular

* To call it cellular coat, however, would be to confound it with the three cellular coats generally enumerated by authors.

† Winflow, fect. viii. p. 64.

end. It is of greater extent than the outer coats of the stomach; which necessarily throws it into folds or plicæ. These folds take, in different animals, a variety of forms: but they are simple in man; from the œsophagus they are continued in a stellated form upon the orifice, but form no valve here. In the body of the stomach they are more irregular, sometimes retiform, and sometimes they form circles or squares, but they have generally a tendency to the longitudinal direction. In the pyloric orifice the villous coat forms a ring, called the valve of the pylorus, which, however, has no resemblance to a valve in its form or action. This ring is not formed by the inner coat of the stomach alone, but by the inner stratum of fibres of the muscular coat, the vascular and cellular coats, and the inner or villous coat. The effect of all these coats, reflected inward at the lower orifice, is to form a tumid and pretty thick ring, which appears like a perforated circular membrane when the stomach has been inflated and dried; but in neither state is its direction oblique so as to act as a valve. It seems capable of resisting the egress of the food from the stomach, or the return of the matter from the duodenum, merely by the action of the circular fibres which are included in it.

On the surface of the inner coat of the stomach, small retiform rugæ and a pile of innumerable villi are observed. But this structure of the stomach has not been so fully examined, and is not so perfectly understood as the analogous appearance in the intestines. Glands are also described as opening upon the inner surface of the stomach: and those who have not been able to see these glands, which are seated in the third cellular coat, yet believe in their existence from analogy; while others observe foramina toward the upper and lower orifice of the stomach, which they suppose to be the opening or ducts of glands. These, however, which I believe to be merely cryptæ or follicles, are themselves the secreting surface, and not the ducts of the proper round glandular bodies; at the same time it must be admitted that disease, as if magnifying and giving size to the structure of the stomach, shews a glandular and tuberculated structure.

Gastric fluid. There is secreted into the stomach a fluid, which is the chief agent in digestion. The most common opinion is that it flows from the extreme arteries of the villous coat in general, partly from the mucous cryptæ and ducts.*— When pure, it is a pellucid, mucilaginous liquor, a little salt

* But I ſhould conſider theſe glands rather as analogous to the mucous follicles of the œſophagus and lower portion of the inteſtine, and merely as lubricating and defending the paſſages.

and brackish to the taste like most other secretions, and having the power of retarding putrefaction and dissolving the food.— It acts on those substances which are nutritious to the animal, and which are peculiarly adapted to its habits. It has, consequently, some variety of properties in different animals.— The secreting powers of the stomach seem so far to accommodate themselves to the food received into it, that the property of the gastric fluid is altered according to the nature of the food. This affords another argument in favour of a simple diet; since in a variety of condiments received promiscuously into the stomach, the chance is the greater of some ingredient becoming an offensive load.

It seems to be a peculiarity in the human stomach, that it has a greater capacity for digesting a variety of animal and vegetable bodies. But I should at the same time conceive that the natural power of digesting the simple and appropriate food is diminished as the stomach gains the power of dissolving a variety of substances. In other creatures, a sudden change of food is rejected, and the powers of the stomach are found incapable of acting duly on the aliment, though time so far accommodates the gastric fluid to the ingesta that the animalization becomes perfect. Mr. Hunter speaks of the power of cattle eating and digesting their secundines.* I have known a cow die from this; the membranes being found coiled up within the bowels. But the fact is sufficiently ascertained, that the nature of the digestive process may be so far altered that gramenivorous animals may be made to eat flesh, and carnivorous animals brought to live upon vegetables. This fact throws us back from the simple idea which we should be apt to entertain of the nature of the change produced by digestion, viz. that it is simply chemical. For we see that the nature of the solvent thrown out from the stomach, and its chemical properties, may be changed by an alteration in the action of the coats of the stomach. Thus we are baffled in our inquiries, and brought back to the consideration of this living property, which can so accommodate itself to the nature of the aliment.

The gastric fluid has been collected from the stomachs of animals after death, by sponges which the animal has been made to swallow, or which have been thrust down into its stomach, incased in perforated tubes. And, lastly, it has been obtained by exciting the animal to vomiting, when the stomach was empty; for the secretions of the stomach are then poured

* See Obſervations on Digeſtion.

out unmixed with food.* Although by these means a fluid may be obtained which may properly be called the succus gastricus, yet it must contain a mixture of the saliva, and secretions from the glands of the œsophagus and pharynx, with the glandular secretions of the stomach, and the general vascular secretion from the surface of the stomach. It is a fluid, then, upon which the chemist can operate with no hope of a successful or uniform result. And indeed chemistry seems no farther to assist us in forming an accurate conception of the changes induced upon the fluids in the alimentary canal, than that the more perfect, but still very deficient, experience of the modern chemist successfully combats the speculations of the chemists of former ages. For example; it was formerly supposed that digestion was a fermentation, and that this fermentation was communicated and propagated by the gastric juice. It is now found that the gastric juice has properties the reverse of this; that it prevents the food from taking an acid or putrefactive fermentation; that it acts by corroding and dissolving the bodies received into the stomach; and that it is itself at the same time converted into a new fluid, distinct in its properties.† It is almost superfluous to observe, that the gastric juice has no power of acting upon the coats of the stomach during life; whether this be owing to the property, in the living fibres, of resistance to the action of the fluid, or that there is a secretion bedewing the surface, which prevents the action, it is not easy to say, but more probably it is owing to the resistance to its action inherent in a living part.

Of digestion. By trituration and mastication, and the union of the saliva with food in the mouth, it is merely prepared for the more ready action of the stomach upon it. No farther change is induced upon it than the division of its parts and the forming of a soft pulp. But in the stomach, the first of those changes (probably the material one) is performed, which by a succession of actions fits the nutritious matter for being received into the circulation of the fluids of the living body, and for becoming a component part of the animal. For now the gastric juice acting on this fluid mass quickly dissolves

* By Spallanzani.

† The moſt curious fact is that property of the coats of the ſtomach, or of the fluids lodging in the coats of the ſtomach, by which milk and the ſerum of the blood are coagulated. It has been found that a piece of the ſtomach will coagulate ſix or ſeven thouſand times its own weight of milk. This action ſeems a neceſſary preparation for digeſtion, which ſhews us that the moſt perfect and ſimply nutritious fluid is yet improper, without uudergoing a change, to be received into the ſyſtem of veſſels. For example; milk and the white of eggs are firſt coagulated, and then paſs through the proceſs of digeſtion. See J. Hunter, Animal Œconomy, Obſervations on Digeſtion.

the digestible part, and entering into union with it produces a new fluid, which has been called chyme. The mass has changed its sensible and chemical properties; it has suffered the full action of the stomach, and by the gradual and successive muscular action of the stomach it is sent into the duodenum. The contents of the stomach consist of air (partly swallowed, partly extricated by chemical change, but still more in all probability by the heat); of chyme; and of a grosser part incapable of becoming nutritious, and the separation of which from the chyme is accomplished by the action of the canal. Now the stomach being stimulated by fulness, by flatus, and more still by the peculiar irritation of the food to which it is natural to suppose its sensibility is adapted, the muscular coat is brought into action, and the contents of the stomach delivered into the duodenum. Here having additional ingredients, it is farther changed in its nature, and approximates more to that of the fluids circulating in the vessels. It is called chyle; it has become a white milky fluid, which by the property of the living surface of the villous coat is separated from the mass, and absorbed by the lacteal vessels of the intestines*.

Hunger and thirst. We are solicited to take food by the uneasy sensation of hunger, and by the anticipation of the voluptuous sating of the appetite, and by the pleasures of the palate. Hunger is considered as the effect of the attrition of the sensible coats of the stomach upon each other by the peristaltic motion of the stomach and compression of the viscera. This appears to be too mechanical an explanation. If the sensation proceeded merely from such attrition of the coats of the stomach, food received into the stomach would be more likely to aggravate than to assuage the gnawing of hunger; to excite the action of the stomach would be to excite the appetite, and an irritable stomach would be attended with a voracious desire of food. Something more than mere emptiness is required to produce hunger. There appears to be a deficiency of the due stimulus to the stomach, and a consequent uneasy sensation which is allayed by fulness. Hunger does not appear to be occasioned by stimulus, but by a want of due excitement, by which the irritability of the coats and action of the vessels are as it were suffered to accumulate; and this tension, and irritation, and fulness of vessels, is relieved by the food, which excites the action, draws out the fluids, and gives activity to the system of vessels.

Thirst is seated in the tongue, fauces, œsophagus, and

* See farther of the lacteal and absorbent system.

stomach. It depends on the state of the secretions which bedew these parts, and arises either from a deficiency of secretion or from an unusually acrid state of it. It would appear to be placed as a monitor calling for the dilution of the fluids by drink, when they have been exhausted by the fatigue of the body and by perspiration, or when the contents of the stomach require a more fluid state,—the more easily to suffer the necessary changes of digestion.

The cardiac orifice is the chief seat of all sensations of the stomach both natural and unusual, as it is the most sensible part of the stomach, Indeed we might presume this much by turning to the description and plates of the nerves; for we shall find that this upper part of the stomach is provided in a peculiar manner with nerves, the branches of the par vagum.

The sympathy of the stomach with the rest of the intestinal canal, the connection of the head and stomach in their affections, the effect of the disorder of the stomach on the action of the vascular system and of the skin, and the strict consent and dependence betwixt the stomach and diaphragm and lungs, and in a particular manner with the womb, testicle, &c.—and again, the connection of the stomach with the animal œconomy, as a whole,—must not escape the attention of the student of medicine.

SECTION III.

OF THE SMALL INTESTINES.

The small intestines are described as that part of the intestinal canal which is betwixt the pyloric orifice of the stomach and the valve of the colon. They are reckoned in length at four or five times the height of the body: they form that part of the canal in which the digestion is completed, and the nutritious fluids absorbed from the waste of the ingesta. They are commonly subdivided into the duodenum, jejunum, and ileon; or more simply into the duodenum and intestinum tenue*.

OF THE DUODENUM.

The duodenum stands distinguished from the general tract of the small intestines by its shape, connections, and situation.

* Haller.

It is greatly larger than any other part of the small intestines; irregularly circular; more fleshy; and, although it has fewer plicæ, it is more glandular and more vascular: but its greatest peculiarity, and that which must convince us of its importance in the animal œconomy, and of the necessity of attending to it in disease, is this, that it is the part which receives the biliary and pancreatic ducts, and in which a kind of second stage of digestion takes place; and that by the disorder of these secretions it must be primarily affected. The duodenum takes a course across the spine from the orifice of the stomach until it touches the gall-bladder. First it goes in a direction downward; then it passes upward till it touches the gall-bladder; then making a sudden turn it descends directly near to the right kidney, and is then involved in the lamina of the mesocolon; it then takes a sweep towards the right side, obliquely across the spine, and a little downward; it afterwards runs behind the head of the pancreas and the great vessels passing to the small intestines betwixt the vena cava and the vena portæ; and then again toward the left of the aorta, but still bound down by the root of the mescolon*. This portion of the intestine receives its name from being usually measured off twelve fingers breadth, or from five to six inches, from the orifice of the stomach. I have always preferred, however, a natural and not an arbitrary division, and have considered that portion of the intestines as duodenum, which is above the lower lamina of the mesocolon, or the point at which it emerges from the stricture of the mesocolon. As in this extent, besides being tied down to the spine by the mesocolon, it has the peritoneum reflected off from it at other points, we have to remark the ligamentum duodeni renale, ligamentum duodeni hepaticum.

Although we shall presently treat of the coats of the small intestines in general, yet it may not be improper here to observe what are announced as peculiarities in the coats of this first division. The first or peritoneal coat is imperfect, as must already be understood: for it does not invest the whole circumference of the gut; it ties it down more closely, or it merely contains it in its duplicature, while a greater profusion of cellular membrane accompanies this than the other divisions of the intestines. The muscular coat is stronger than that of the jejunum and ileon; the plies formed by the inner coats,

* How comes it then, feeing the acute turns of this inteftine, that Ruyfch calls it "Inteftinum digitale, vel inteftinum rectum breviffimum?" Adverfar. Anat. Decad. II.

See a good defcription of the duodenum by M. Laurent Bonazzoli, in the Tranfactions of the Academy of Bologna.

smaller than those of the other part of the small intestine, and having more of a glandular structure. At the lower part of the first incurvation of the duodenum, the inner coat forms a particular process like to those which are called valvulæ conniventes ; and in this will be discovered the opening of the biliary duct, within which also the ductus pancreaticus generally opens.

It is not without some reason that anatomists have considered the duodenum as a second stomach, calling it ventriculus secundus, and succenturiatus ; for there is here performed a change upon the food, converting the chyme, (as they have chosen to call it,) which is formed in the stomach, into perfect CHYLE. But to suppose that the chyme is perfected in the duodenum, is to suppose the biliary and pancreatic secretions necessary to the formation of chyle ; a point which is not allowed : for many suppose that the bile is merely a stimulus to the intestines, holding a controul over their motions ; others, that it is useful only in separating the chyle from the excrement ; or again, that the bile is decomposed, part entering into the composition of the chyle, while the other goes into that of the fæces : it seems to bestow upon them a power of stimulating the intestinal canal in a greater degree ; and as the chyle is formed occasionally without the presence of bile, we may be induced the more readily to allow that the bile does not in the natural actions and relations of the systems enter into the composition of the chyle. At all events, we see that it is the bile which is the peculiar stimulus of the intestinal canal, and that when interrupted in its discharge from the ducts, the motions of the belly are slow, and costiveness is the consequence.

We see, then, that at all events there are poured into the duodenum from the liver and pancreas, secretions which have an extensive effect on the system of the viscera ; and we must acknowledge that the derangement of these secretions must operate as a very frequent and powerful cause of uneasiness, and that the duodenum must often be the seat of disease and distressing symptoms. We may observe that, from the course of the duodenum, pain in it should be felt under the seventh or eighth rib, passing deep, seeming to be in the seat of the gall-bladder, and stretching towards the right hypochondrium, and to the kidney, and again appearing as if on the loins. We may observe farther, that from the connections of this portion of the intestine, and from the manner in which it is braced down by the mesocolon, spasm, when flatus is contained in it, will sometimes produce racking pains. Nay farther, when the irregularities of digestion affect the duodenum, and spasm and distention follow ; the distention causes it to

press upon the gall-bladder, and the pressure and the excitement together cause an irregular and often an immoderate flow of bile, which with the acrid state of the food, produces anxieties and increased pain, inverted motion, vomiting, and even cholera.*

We must not forget, that the inverted action of the stomach draws quickly after it the inverted motion of the duodenum. It may be of consequence to attend to this in the operation of an emetic, for the stomach will sometimes appear to be discharging foul and bilious matter which we naturally may suppose to have been lodged in it, but which has actually flowed from the duodenum, or has even come recently from the ducts in consequence of the operation of the vomit.†

From a defect in the natural degree of the stimulating power of the bile, it will accumulate in the duodenum, occasioning anxiety and loss of appetite, and even congestion of blood and a jaundiced skin; we may certainly affirm that these at least are often connected. Such accumulation in the duodenum must be attended with a languid action of the whole canal, and inactivity of the abdominal viscera, because the peristaltic motion is begun here in the natural action of the intestines; and if its peculiar stimulus be deficient, so must that of the whole system of the viscera. Hence the necessity of rousing and evacuating the whole canal.

I may farther observe, that it has been the opinion of the most respectable old physicians, those whose knowledge of diseases has been drawn from an acquaintance with anatomy, from the frequent inspection of dead bodies, and the observation of the symptoms during life, that the study of the diseases connected with the duodenum is the most important which can occupy the attention of the medical enquirer.

OF THE SMALL INTESTINES IN GENERAL.

The small intestines, under the name of jejunum and ileon, occupy the space in the middle and lower part of the abdomen, the great mass forming convolutions in the umbilical region. The cylindrical canal of the small intestines is gradually and imperceptibly diminished in diameter as it is removed from the lower orifice of the stomach; so that the termination of the ileon in the caput coli is considerably smaller than the duodenum. This tract of the small intestines performs the most im-

* Indeed vomiting in confequence of concuffion and compreffion upon the whole contents of the abdomen, and in a particular manner on the liver, affords moft powerful means of operating upon the infarction and remora of the blood in the hepatic fyftem.

† See Sandifort, vol. iii. p. 288. See Hoffman.

portant function of the chylipoëtic viscera (if any can be said to be peculiarly important where the whole is so strictly connected); for here the food is moved slowly onward through a length of intestine more than four times the length of the body,* and exposed to a surface amazingly extended by the pendulous and loose duplicatures of the inner coat. Here the fæces are gradually separated from the chyle, and the chyle adhering to the villi is absorbed and carried into the system of vessels.

The JEJUNUM† is the upper portion of the small intestine. Its extent is two-fifths of the whole. Its convolutions are formed in the umbilical region.

The ILEON lies in the epigastric and ileac regions, surrounds the jejunum on the sides and lower part, and forms three-fifths of the whole extent of the intestine from the mesocolon to the valve of the colon. The coats of the ileon are generally described as thinner and paler; the valvular projections of the inner coat less conspicuous; and the mucous glands are apparent in the lower portion. The several parts however of this, which we may call the long intestine,‡ do not preserve a very exact relation in regard to their place in the belly, but in their motions they may be drawn to the right or left, upward or downward. This however I am convinced takes place in a much less degree than is generally believed.

There is sometimes found a lusus in the lower part of the ileon before it passes into the colon; a blind pouch or cæcum is, as it were, attached to the ileon resembling the caput coli. I have found this in one instance only. Sometimes there is more than one in the course of the ileon.§

MINUTE STRUCTURE OF THE SMALL INTESTINES.

We have in some measure anticipated the general enumeration and character of the coats of the intestines, by what has

* The whole length of the inteſtinal canal is generally eſtimated at from ſix to ſeven times the length of the whole body.

† So named from its being more generally empty. Indeed the higher parts of the canal can never be diſtended, becauſe the contents paſs ſlowly and gradually and with little interruption through them; but they are in a manner accumulated below.

‡ We may then ſpeak of the ſmall inteſtines in general, meaning the whole tract from the ſtomach to the great inteſtine; the duodenum being the ſpace betwixt the ſtomach and the lower lamina of the meſocolon, the long inteſtine being the tract extending from the duodenum to the colon.

§ The appendices cæcales of the ileon have given birth to a curious queſtion in the pathology of hernia. See "Hernia ab ilii diverticulo." Morgagni, Adv. Anat. III. "Hernie formée par l'appendice de l'ileon." LITTRE, Mem. de l'Acad. Royale des Sciences, an 1700; Ruyſch, Palfin, &c. See caſes of anus at the groin in the Muſeum, Surgeons' Square.

been said upon the coats of the stomach; for we have here to distinguish the four great coats, the peritoneal, the muscular, the vascular, and villous coats.

THE PERITONEAL COAT AND MESENTERY.

The peritoneal coat of the small intestines is of the same nature with that of the stomach, liver spleen, &c. It is a thin, smooth, pellucid membrane. On the surface it has a moisture exuding from its pores; and it firmly adheres to the muscular fibres beneath. Its transparency makes the muscular fibres, blood-vessels, and lymphatics easily distinguishable; and when it is dissected or torn up, the longitudinal muscular fibres will be found in general attached to it. Its use is to give a smooth surface and strengthen the intestine, and in a great measure to limit the degree of this distension.

The peritoneal coat of the intestine is continued and reflected off upon the vessels and nerves which take their course to the intestine: or, what is the same thing, and indeed is the more common description, the two lamina of the peritoneum which form the mesentery, after proceeding from the spine and including the vessels, nerves, and glands belonging to the tract of the intestine, invest the cylinder of the intestine under the name of peritoneal coat.* The mesentery is composed of membranes, glands, fat, and the several systems of vessels, arteries, veins, lacteals, and nerves. As in reality it is a production of the peritoneum, it may be said to arise from the mesocolon, or the mesocolon from the mesentery, reciprocally. But at present we may trace the mesentery from the root of the mesocolon; for the jejunum, emerging from under the embrace of the mesocolon, carries forward the peritoneum with it; and the laminæ of the peritoneum, meeting behind the gut, include the vessels which pass to it and form the mesentery. This connection of the small intestines by means of the prolongation of the peritoneum, while it allows a considerable latitude of motion, preserves the convolutions in their relations, and prevents them from being twisted or involved. But it is by the walls of the abdomen that the intestines as well as the more solid viscera are supported; for when the bowels escape by a wound, a portion of an intestine will hang down upon the thigh, unrestrained by the connection with the mesentery.

The mesentery begins at the last turn of the duodenum, or beginning of the jejunum. Its root runs obliquely from left to right across the spine. Here it has no great extent; but as

* See Plate I. 5. 6. 7. 8.

it is prolonged toward the intestines, it spreads like a fan, so that its utmost margin is of very great extent; which may be conceived when we consider that it is attached to the whole extent of the small intestines. In the middle of the small intestine, the mesentery has its greatest extent or breadth; towards the beginning of the duodenum and the termination of the ileon, it is shorter, and more closely binds down the intestine.

MUSCULAR COAT OF THE INTESTINES.

There is not a more important point of consideration in the anatomy of the viscera, than this of the action of the muscular coat. The appearance and course of the fibres shall first be described, then their action, and lastly their effect in disease.

The peritoneum is united to the muscular coat by a very delicate and dense cellular membrane; which in the enumeration of the coats we must call the first cellular coat, but which really does not deserve the name of a distinct coat; for, as already said, the outer lamina of the muscular coat is raised with the peritoneum, and adheres intimately to it. The fibres of the muscular coat of the intestines are simpler than those of the stomach; for here there are only two sets of fibres, the longitudinal and circular fibres. The outer stratum consists of the very minute and delicate longitudinal fibres. Indeed, when the system has been exhausted by a long and debilitating illness, with scarcely any excitement of the intestinal canal, these fibres are not to be observed. In a man who has been cut suddenly off by disease, or who has died a violent death, they become more demonstrable; and in diseases where there has been congestion and excited action in the intestines, they are of course still stronger and more discernible. The internal stratum of the muscular fibres is much stronger and more easily demonstrated. These fibres will be observed much stronger about the duodenum and upper part of the jejunum, but they become weaker and more pellucid towards the extremity of the ileon. Tracing any particular fibre of the circular stratum, it is found to form only a segment of a circle, a part of the circuti of the intestine. It seems lost amongst neighbouring fibres or cellular connections; but still, taken together, the circular muscular fibres uniformly surround the whole gut.*

To account for that action of the intestines which urges on the food, we may suppose a greater degree of irritability and activity to reside in the upper portion, where of course is commenced that action which is successively propagated downward, carrying the fæces into the lower part of the canal.

* Morgagni Adverſaria Anatomica III. Animadverſio V.

Some anatomists have ingeniously imagined that the inner stratum of fibres surrounds the intestine not in a circular direction, as was asserted by Willis, but obliquely and in a spiral course; from which followed a simple explanation of their effect, since the contraction of the fibre winding lower in the intestine pursued the contents with a uniform progressive constriction.

Physiologists have made a distinction in the motion which they have observed in the intestines of living animals. The one they call the vermicular, and the other the peristaltic motion. Upon looking into the belly of a living animal, or of one newly killed, there may be observed a motion among the intestines, a drawing-in of one part and a distention and elongation of another part of the convolution. This motion has some resemblance to the creeping undulating motion of a reptile, and has got the name of vermicular motion. On the other hand, the direct contraction of the gut by the constriction of the circular fibres is the peristaltic motion. We must not however allow ourselves, from the loose expression of authors, to imagine, that these circular straight fibres act separately: on the contrary, excited by the same stimulus, they have a simultaneous motion to the effect of accomplishing the perfect contraction of the gut and motion of its contents.*

While the stimulus is natural, the contraction of the muscular coat is in a regular series from above downward, and, the lower part contracting before the upper is completely relaxed, the food must be urged downward into the lower portion. I should even imagine that the lower portion is relaxed, from its more usual degree of tension, or slighter permanent degree of action†.

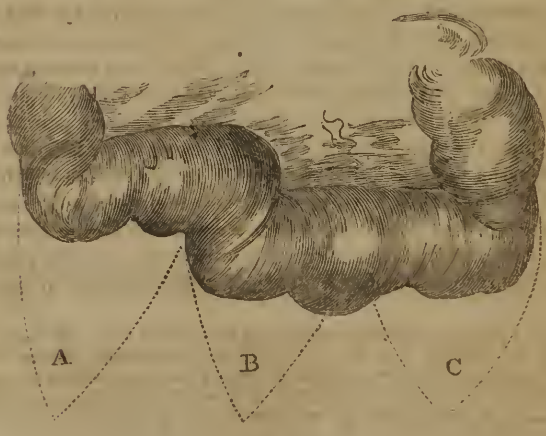
ANTIPERISTALTIC MOTION.

When the succesive contraction of the muscular fibres of the intestines is opposed in its natural course downward, either by a violent stimulus (the effect of which is to cause a more permanent contraction in the coats, and one which does not

* Neither can I allow that the acting of the longitudinal fibres in one portion of an inteſtine dilates that which is below, otherways than by the compreſſion of food and flatus.

† From the experiment of Haller and of others, it is proved that the irritability of the inteſtines long ſurvives that of the heart: that the inteſtines are in general in lively motion, when no motion can be obſerved in the ſtomach: but that ſometimes the motion of the ſtomach continues longer than that of the inteſtines. It is proved alſo that the action of the inteſtine is adequate to the motion downward and the diſcharge of fæces, without the aid of the abdominal muſcles. See *Mem. ſur Haller ſur les Mouvemens des Inteſtines.*

readily yield to the relaxation that follows, as in the natural contraction), or when there is a mechanical and obstinate interruption to the contents of the bowels; then is the natural action reversed. This antiperistaltic motion must arise thus; a portion of the intestine being constricted, and not yielding to the contraction which in the natural action of the gut should follow in order, the motion of the gut must be stationary for a time, until the part above is again relaxed; when, the contents of the intestine finding a free passage upwards, and that portion contracting and propelling the matter still upwards and retrograde, (since it is opposed by the contraction below,) a series of retrograde or antiperistaltic motions are produced. The course of the action is changed; the contraction of the gut is not followed by the dilatation of the part below, but by that of the part above. By this means the matter of the lower portion of the intestinal canal is carried into the upper part, and there acting as an unusual stimulus it aggravates and perpetuates the unnatural action. Nay, from experiments it appears that a permanent irritation will cause an accelerated motion in both directions, that from the point stimulated there will proceed downward the regular series of contractions and dilatations, while the motion is sent upwards and retograde from the same point of the intestine toward the stomach*. And this observation, the exhibition of medicine and the diseases of the intestines confirm. But farther we may observe, that the food is not uniformly moved downward; it is shifted and agitated by an occasional retrograde motion thus:



* Haller, loc. cit., Exper. 424.

The portion of the intestine included under A contracts and sends its contents into B. B contracting sends its fluid contents in part backward into A, but in a greater portion into C. While the contents of the middle portion are sent into the lower part in a greater proportion than into the higher division, the tendency of the food will be in its natural course, downward; whilst at the same time it suffers an alternate motion backward and forward; so that it is more extensively applied to the absorbing surface of the intestines.

The stimulus to the intestines is matter applied to their inner coat; and although there is much sympathy in the whole canal, yet unless there be matter within a portion of the canal, that particular part has little action. Accordingly, when there is obstruction to the course of the aliment, by whatever cause it may be produced, the portion below becomes shrunk and pale, and free from the effects of inflammation; while that stimulated by the food, being in a high state of excitement, irritated by the presence of matter which it is unable to send forward, evacuated only partially by an unnatural and highly excited retrograde action, it becomes large, thick in its coats, strong in its muscular fibres, and greatly inflamed, till it terminate at last in gangrene*.

The unusual excitement of the muscular fibres produces a very curious effect in the intus-susceptio, or the slipping of one portion of the gut within another. This may be done by applying acrid matter to the intestines of living animals; and I have no doubt that it has been produced by giving purges too strong and stimulating in cases of obstruction of the bowels. By the contractions of the muscular coat greatly excited, the intestine is not only diminished in diameter so as to resemble an earth-worm†, but in length also. This great contraction of the outer coats accumulates the vascular and villous coat as if into a heap; which from the compression of the muscular coat is forced into the neighbouring relaxed portion. This first step leads only to a succession of actions; for the fibres of the relaxed or uncontracted part, sensible to the presence of this accumulated and turgid villous coat, contracts in succession so as to draw a part of the contracted gut within the relaxed portion. If the irritation is done away or ceases quickly, as in the ex-

* Haguenot gives an experiment illuſtrating the cauſe of ileus. He tied a ligature about the inteſtine of a cat, and found no antiperiſtaltic motion excited. This is not wonderful; it is the excitement ariſing from matter within the gut, to which there is no exit, and not the ſtricture of it, which is the cauſe of the violent ſymptoms.—A caſe in the Muſeum will give the young ſtudent a correct judgment on this ſubject.

† See Haller's Experiments; and "Diſſections of the Atrophia Ablactatorum;" with plates; by Dr. Cheyne.

periments on animals, another turn of the intestine coming into play distends this, and undoes the intus-susceptio. But if the cause continues, the intus-susceptio is continued; the included part of the gut is farther forced into the other. By these means the vessels going to the included part are interrupted; the villous coat swells more and more; and several feet of the upper portion of the intestine is often in this way swallowed down. It is not however in the natural course downward that this preternatural action always proceeds; for, as the excitement is violent and unlike the usual stimulus of food, and as we know that an unusual excitement is very apt to cause an inverted action, it often happens that the intus-susception is formed by the lower portion of the gut included in the upper part.

VASCULAR COAT.

This third coat of the intestines, or what is commonly called the nervous coat, is a stratum of cellular membrane in which the vessels of the gut are distributed. It might with equal propriety be called the cellular coat; and is indeed what some anatomists have called the third cellular coat. By inverting the gut and blowing strongly into it, the peritoneal coat cracks and allows the air to escape into this coat; which then swells out, demonstrating its structure to be completely cellular*. Its use evidently is to suffer the arteries, veins, and lymphatics to be distributed to such a degree of minuteness as to prepare them for reflection into the last and innermost coat, and for entering into the structure of the villi: for they come to the extremity of the mesentery as considerable branches, but forming in this coat a uniform texture of vessels, their extreme branches are finally distributed to the inner coat. This is the coat in which, in some parts of the intestines, little glands or criptæ are lodged.

VILLOUS COAT.

The most curious part of the structure of the intestines is the villous or inner coat; for by its organization is the chyle separated from the general mass of matter in the bowels, and carried into the system of vessels. To this all we have been describing is merely subservient.

The villous coat has a soft fleecy surface; and being of

* An experiment, to which Albinus attaches much importance. See alſo, in the Acad. de Bologna, a paper by Mr. D. G. Galeati on the fleſhy coat of the ſtomach and inteſtines.

greater extent than the other and more outward coats, it is thrown into circular plaits which hang into the intestine, taking a valvular form. They have the name of VALVULÆ CONNIVENTES. Some of them go quite round the inside of the intestine; others only in part. They are of larger or smaller extent in different parts of the canal: for example; they begin a very little way from the lower orifice of the stomach irregularly, and tending to the longitudinal direction; further down they become broader, more numerous, and nearly parallel; they are of greater length, and more frequent in the lower part of the duodenum and upper part of the jejunum.—These valvular projections have their edges quite loose and floating in the canal; and from this it is evident that they can have no valvular action. Their use is to increase the surface exposed to the aliment; to enlarge the absorbing surface; and at the same time to give to it such an irregularity that the chyle may lodge in it and be detained*. Into the structure of these plicæ of the villous coat, the vascular or cellular coat enters, and generally in the duplicature a small arterial and venous trunk will be observed to run. That these plicæ are formed chiefly by the laxity of the connection and the greater relative extent of the inner coat, is apparent upon inverting the gut, and insinuating a blow-pipe under it, for then you may distend the cellular substance of the vascular coat so as entirely to do away the valvulæ conniventes.

The pile or lanuginous surface from which this coat has its name, is to be seen only by a very narrow inspection, or with the magnifying glass. It is owing to innumerable small filaments which project from the surface, like hairs at first view, but of a flat or rounded figure as the state of fulness and excitement or depletion shows them. They consist (as appears by the microscope) of an artery and vein, and lacteal or absorbing vessels, and to these we may surely add the extremity of the nerve. They have a cellular structure; they are exquisitely sensible; and, when stimulated by the presence of fluids in the intestines, are erected, and absorb the chyle. They are the extremities of the lacteal absorbing system, and their structure would seem to be subservient to the absorption by the mouth of the lacteal vessel†.

But the surface of this coat is not only an absorbing one, it

* "Superficies internæ hujus tunicæ ad menſuram geometricam, aliquoties integumentorum communium ſuperficiem amplitudine ſuperat." Soemmering, vol vi. p. 295.

† See further of their ſtructure under the title of the LACTEAL and LYMPHATIC SYSTEM, in this volume, where the ſubject of abſorption and the ſtructure of the villi is treated.

also pours out a secretion: and indeed it is as a secreting surface, upon which medicines can act, that it is to us one of the most powerful means of acting upon the system in disease. The fluid which is supplied by the surface of the intestines is called the liquor intericus; a watery and semipellucid fluid, resembling the gastric fluid. This fluid, physiologists have affected to distinguish from the mucous secretion of the glands of the inner surface of the intestines; but it is impossible to procure them separate*.

GLANDS.

Anatomists have observed small mucous glands seated in the cellular membrane of the intestines†, the ducts of which they describe as opening on the villous surface of the intestines. They are seen as little opaque spots, when the intestine is cut in its length and held betwixt the eye and the light. They have been chiefly observed in the duodenum; few of them in the general tract of the small intestines. Little collections or agmina are observed, which increase in frequency toward the extremity of the ileon. It is natural to suppose that as the contents of the intestines become in their descent more acrid and stimulating, there will be a more copious secretion of mucus in the lower intestines for the defence of the villous coat.

SECTION IV.

OF THE GREAT INTESTINES.

The great intestines form that part of the intestinal canal which is betwixt the extremity of the ileon and the anus. They differ essentially from the small intestines in their size, form, and general character; and in the texture, or at least in the thickness of their coats.

The great intestine, beginning on the right side of the belly,

* It has been fuppofed that the fluids excreted from the furface of the inteftines were furnifhed by very minute foramina (which are vifible by particular preparation) in the inteftices of the villi. See the letter of Malpighi to the Royal Society of London on the Pores of the Stomach; and the paper by M. Galeati in the Bologna tranfactions on the Inner Coat, which he calls the Cribriform Coat. Thefe pores, according to Galeati, are vifible through the whole tract of the canal, and particularly in the great inteftines.

† Peyruf. Biblio. Manget. Brunnerus de glandulis duodeni. Wepfer, Morgagni, &c. Thefe he fuppofed additional pancreatic glands.

rises before the kidney; passes across the upper part of the belly, under the liver, and before or under the stomach*. Then making a sudden angle from under the stomach and spleen†, it descends into the left iliac region. Here, making a remarkable turn and convolution, it descends into the pelvis by a curve running in the hollow of the sacrum.

The great intestines are accounted to be about seven feet in length, and to bear a relation to the small intestines as five to twenty-five.

The natural division of this portion of the intestine is into the cœcum, colon, and rectum‡.

VALVULA COLI.

The extremity of the intestinum ileon enters as it were into the side of the great intestine at an angle§. And here there is a valvular apparatus formed by the inner membrane of the gut, which, more than any other circumstance, marks the distinction betwixt the small and great intestines; for as the effect of this valve is to prevent the regurgitation of the fæces into the small intestines, it marks sufficiently the nature of the change produced on the injesta in their passage through the small intestine, and how unfit in their acrid and putrescent state they are to be longer allowed lodgment there.

Upon opening the caput coli, or lower part of the colon, on the right side, and examining the opening of the ileon into it, we see a slit formed betwixt two soft tumid plicæ of the inner membrane of the gut: the one of these is superior; the other inferior. They are soft, and moveable, and seem scarcely calculated for a valvular action. But there is little doubt that when the great gut is distended or in action, they are calculated to resist the retrograde passage of the fæces into the ileon. In the oblong opening of the ileon, and in the broadness of the valvular membranes, there is considerable variety. The superior valve is transverse, smaller and narrower than the lower one; the lower one is longer, and takes a more extensive curve: and sometimes the lower one is so remarkably larger than the upper valve, that it gives a great degree of obliquity to the insertion of the ileon into the colon, so as to ap-

* This turn of the colon from the right acrofs the belly is flexura prima, fuperior dextra hepatica Soemmering.

† Flexura fecunda, fuperior finiftra lienalis.

‡ Some authors divide the great inteftine into fix parts, enumerating the cœcum; pars vermiformis; the right; the left; and the tranfverfe colon; and the laft part or rectum.

§ Of the entering of the fmall inteftine into the greater, fee Morgagni Adverfar. iii. Animad. xi.

proach to that structure which we see in the entrance of ducts, as the biliary duct into the intestine, or the ureter into the bladder. At the extremities of these valves they coalesce and run into the common transverse folds of the colon: and this is what Morgagni has called the fræna. At this place of union of the ileon and colon the longitudinal muscular fibres of the ileon are mingled and confounded with the circular fibres of the colon*. The circular muscular fibres certainly enter so far into the composition of the valve, that they embrace the margin, and, by contracting during life, must make the experiments on the action of this valve in the dead body less decisive than they would be were we certain that this valve acts on principles strictly mechanical.

The discovery of the valve of the colon, and which, from its action in guarding the ileon, might rather be called the valve of the ileon, has been claimed or attributed to many anatomists, chiefly to Varolius, Bauhin, and Tulpius; and it sometimes receives the name of the two latter anatomists.

CŒCUM.

We have seen that the ileon is inserted into the side of the colon: now that portion of the gut which is below this union of the ileon is a round or slightly conical sac, from two to three inches in length. It is attached by cellular membrane to the iliacus internus muscle. It is not a regular sac, but is divided into large cells like those in the rest of the colon, and has considerable varieties in different subjects.

PROCESSUS, SEU APPENDIX VERMIFORMIS.

There is appended to the cœcum a small gut, also blind; but bearing no relation in size or in figure to any part of the intestinal canal. This gut, from its smallness and twisted appearance, like the writhing of an earthworm, has received the name of vermiformis. It is somewhat wider at the connection with the great intestine, and stands off obliquely, so that sometimes its inner membrane takes the form of a valve†. It scarcely ever is found containing fæces, but only a mucus excreted from its glands. In the fœtus the appendix vermiformis is comparatively much larger, its base wider; upon the whole, more conical, and containing meconeum; and in the young child it often contains fæces.

* Winflow.

† Morgagni. M. Laur. Bonazzoli in the Acad. of Bologna.

GREAT DIVISIONS OF THE COLON.

The great divisions of the colon (which I conceive it necessary to enumerate, chiefly with a view to the accurate description of the seat of disease) are these: First, the RIGHT DIVISION of the COLON rises from the insertion of the ileon, and from that part of the great intestine which is tied down by the peritoneum and cellular membrane, and ascends on the right side of the small intestines, until it gets under the margin of the liver, and in contact with the gall-bladder. Of course, this part will be found to take some considerable varieties in its form, depending upon its state of distention.

THE TRANSVERSE COLON*.

The transverse colon is that part of the great intestine which often takes a course directly across the belly, but which generally forms an arch before or immediately under the stomach. When this part of the colon however is much distended, being at the same time held down by the mesocolon, its angular turns reach under the umbilicus, nay even to the pelvis. For the varieties in the situation of this intestine and the viscera in general, see Morgagni Adversar. Anat. ii. Animadver. ii.

The LEFT OR DESCENDING COLON is short: for between the point, where the colon begins to bend down on the left side, and those violent turns which it takes before terminating in the rectum, is but a short space. It is here attached to the diaphragm and psoas muscle.

The SIGMOID FLEXURE of the colon† is formed by a narrowing and contraction, and closer adhesion of the gut to the loins below the left kidney, and to the cup of the ileum by the peritoneum, which seems to have the effect of throwing it into some sudden convolutions. The colon then terminates in the rectum.

PECULIARITIES IN THE COLON DISTINGUISHING IT FROM THE SMALL INTESTINES.

The coats of the great intestines are the same in number and in structure with those of the small intestines; but they are thinner and more difficult to be separated by dissection. The villi of the inner coat are smaller; the mucous glands or foli-

* COLON TRANSVERSUM. ZONA COLI.
† From its refembling the Roman S.

cules are sometimes very distinct; and, lastly, the muscular fibres have some peculiarities in their arrangement. The most characteristic distinction in the general appearance of the great and small intestines, is the notched and cellular appearance of the former. The cells of the colon, being formed betwixt the ligamentous-like stripes which run in the length of the gut, have a regular three-fold order. These cells give lodgment to the fæces; retain the matter; and prevent its rapid descent or motion to the rectum. Here the fluids are still more exhausted, and the fæces take often the form of these cells. When the great intestines are torpid, and inert in their motions, the fæces remain too long in the cells of the colon, and become hard balls or scibulæ. But when in this state of costiveness the intestines are excited by medicine, not only is the peristaltic motion of the intestines increased, but the vessels pour out their secretions, loosening and dissolving the scibulæ*.

MUSCULAR COAT.

The ligamentous-like bands of the colon form three fasciculi running in the length of the gut: one of these, obscured by the adhesion of the omentum, is not seen without dissection; and the other is concealed by the mesocolon†. These bands are formed by the longitudinal fibres of the gut, being concentrated into fasciculi, and not uniformly spread over the general surface, as in the small intestines: and being at the same time more firmly connected with the peritoneal coat, they give the appearance outwardly of ligament more than of muscular fibres‡. The inner or circular muscular fibres of the great intestines are like those of the small intestines, uniformly spread over their surface, and are stronger than those of the latter.

FÆCES. That the food digested, in part absorbed, and its fluids exhausted, becomes fæces in its progress through the intestines, will be universally allowed: but how much of the excrementitious matter in the colon is a human secretion is not equally attended to. Men who have died of want, and men exhausted by long fever or other distress, and who did not or were incapable of taking nourishment, have had discharges of fæces; and fæces are found in their intestines upon dissection.

* See note of the pores of the inteſtines.

† Stratum liberum, ſtratum omentale & tertium Meſocolicum. Soemmer, § ccxxx.

‡ See Morgagni. See alſo Galeati on the fleſhy coat of the ſtomach and inteſtines, in the Memoirs of the Acad. of Bologna.

The fœtus has the intestines filled with meconium*. The effect of a purge is not only to stimulate the intestines to throw off their contents, but the inner secreting surfaces pour out their fluids. The surface of the intestines is not only calculated to absorb nourishment, and capable of throwing off the fluids from the system, like the kidneys in secreting the urine, but it seems destined in a particular manner to carry off the earthy parts of the body, which in the circle of actions is alternately undergoing renovation and decay. Thus the fæces consist of the food and chyme, which has not been converted into chyle and absorbed, but which has been decomposed, and has entered into new combinations; it is united to part of the bile, which has also been decomposed; to the secretion of the pancreas; to the secretion of the immense extent of surface of the intestines; and many substances are found in the excrements which did not exist in the food. From the same sources (viz. the secretions poured into the intestinal canal, or directly from its surface) are formed concretions, often of an enormous size; often distinct from the nature of the more common biliary secretions†; and sometimes these earthy deposits entering into the composition of the fæces, give to them a stoney hardness.

RECTUM.

The RECTUM forms the last division of the great intestines; and I know no better proof of the impracticability of altering the names in anatomy than this, that anatomists have, in almost every age, insisted on the impropriety of calling this gut, which answers in its shape to the curve of the sacrum, a straight gut; and yet always, and to the present day, it is rectum.

From the last turns of the colon, called sigmoid, the gut is continued over the promontory of the last vertebra and sacrum (a little to the left side), and falls into the pelvis. It runs down, in a curved direction, betwixt the sacrum and bladder of urine. In the upper part it is covered by the peritoneum, and has its fatty appendages like the colon, but less regular; and sometimes the fat merely deposited under the peritoneal coat. It is tied down by the peritoneum, in form of mesorectum; but, deeper in the pelvis, it loses the peritoneum (which, as we have said, is reflected up upon the back of the bladder, and forms here lateral folds), and the rectum is con-

* See Haller Phis. Elem. tom. vii. sect. 6. § 3.
† Haller loc. cit.

nected with the lower part of the bladder and vessiculæ seminales by cellular membrane. In women, the muscular fibres of the rectum and vagina are intimately connected*.

The muscular coat of the rectum is particularly strong. The fleshy bands of the colon, spreading out, are continued down upon the rectum in an uniform sheath of external longitudinal fibres. The circular fibres of this part of the gut are also particularly strong; and towards the extremity, appearing in still stronger fasciculi, they obtain the name of sphincter, of which three are enumerated: and this, to distinguish it from the others, is called the intestinal or orbicular sphincter.

The internal coat of the rectum does not deserve the name of villous, nor of papillaris. Its surface is smooth, and there are often distinctly seen little foramina like the mouths of ducts or folicules, in part the source of the mucous discharge, which is sometimes poured out from this gut. Towards the anus the fold becomes longitudinal, and terminates in the notched-like irregularities of the margin.

CHAP. III.

OF THE SOLID OR GLANDULAR VISCERA OF THE ABDOMEN.

SECTION I.

OF THE LIVER.

OF ITS SEAT, AND CONNECTIONS BY LIGAMENTS, AND OF THE DIVISIONS APPARENT ON ITS SURFACE.

OUR attention is now naturally drawn to the liver, as it holds, in so eminent a degree, the sovereignty over the motions of the intestinal canal, and as it is so strictly connected

* Winflow.

with it by its system of vessels, and by its functions. The liver is the largest viscus in the body, and as in its size and proportion to the whole body it is great, so are its connections in other respects with the whole system very intimate. This is particularly evident in the diseases of the liver, and was the cause of the ancients ascribing to it so eminent a place in the œconomy.

Function of the liver.—In all ages authors have paid particular attention to the liver, and have exercised their ingenuity in giving various explanations of its function. The ancients made it the supreme director of the animal system. They supposed that they could trace the nutritious fluids of the intestines through the meseraic veins into the porta and into the liver, and that it was there concocted into blood. From the liver to the right side of the heart they found the cava hepatica, carrying this blood formed in the liver to the centre of the system: and through the veins they supposed the blood to be carried to the remote part of the body.

The liver is the largest glandular body of the whole system. Its use is to secrete the bile, which is carried into the intestines, and performs there an essential action on the food while passing in the tract of the intestines.

Seat of the liver.—The liver is seated in the upper part of the abdomen, under the margin of the ribs, and towards the right side, or in the right hypochondrium. In the fœtus it occupies more of the left side than it does in the adult. Indeed it is nearly equally balanced in the fœtus, but the older the animal (or at least for the five first years) the greater will be the proportion of it found lodged in the right side.

Without going into the more minúte subdivisions of this viscus, we may observe, that it is more uniform, and smooth, and convex on the upper surface; on the lower, more irregularly concave. Its upper surface is applied in close contact to the concavity of the diaphragm, and in the fœtus its margin is in contact with the abdominal muscles, because it falls lower than the margin of the ribs. Its lower and concave surface receives the convexity of the stomach, duodenum, and colon. In a healthy adult subject the liver does not extend from under the margin of the ribs, unless near the pit of the stomach, but in the fœtus and child it is much otherwise. In a fœtus of the third and fourth month the liver almost fills the belly; it reaches to the navel, covers the stomach, and is in contact with the spleen. After the seventh month other parts grow with a greater rapidity in proportion. Indeed some have affirmed, that the liver, or at least the left lobe, actually de-

creases towards the time of birth*. But from this time to the advance to manhood the chest becomes deeper; the sternum is prolonged; and the diaphragm becomes more concave; so that the liver retires under the margin of the ribs, and its margin on the left side in the adult reaches no farther than to the œsophagus. When however the liver becomes schirrous and enlarged, its hard margin comes down so as to be felt through the abdominal pariës under the border of the chest. This enlargement of the liver, and consequent descent of its margin, is to be felt more easily by grasping the integuments of the belly, as if you expected to lift up the acute edge of the liver, than by pressing with the point of the finger. By this means we shall be sensible of the elasticity and softness below the liver, and of the resistance and firmness of the margin of it. The physician, however, should not forget, that the depression of the diaphragm, and consequent protrusion of the liver by disease in the thorax, gives the feeling of an enlargement and hardening of the liver. The left great division of the liver is perhaps as often diseased and enlarged as the right, in which case it is more difficult to ascertain it by examination, and it must be learnt from other circumstances besides the actual touch.

Neither should a physician be ignorant, that by suppuration in the lungs, and consequent rising of the diaphragm, the liver is elevated considerably, so as to retire farther under the protection of the false ribs†.

M. Portal, by running stilettos into the belly of the subject as it lay upon the table, or was raised into the perpendicular posture, found that in the latter posture the liver shifted two inches. But it is almost superfluous to remark concerning these experiments, that they are by no means conclusive. In the dead body, the abdominal muscles are relaxed; they yield to the weight of the viscera; and the diaphragm is pulled down by the weight of the abdominal viscera. The margin of the liver necessarily falls lower, but in the living body there is a close and perfect bracing of every part by the abdominal muscles; they do not yield, and very little if any alteration can take place in the situation of the viscera.

It must be observed, however, that a considerable motion of the liver is the effect of respiration, and of the action of the diaphragm. This motion is chiefly on the back part of the right lobe of the liver. The left lobe being more on the centre of the belly, and consequently opposite to the centre and less

* M. Portal. Acad. de Sciences, 1773.

† These observations in detail belong to another place.

moveable part of the diaphragm, it is less affected by the respiration than the larger right lobe.

LIGAMENTS OF THE LIVER.

The peritoneum is reflected in such a manner from the neighbouring parts upon the liver as to form membranes receiving the name of ligaments. It has been explained, however, that these are not the sole support of this viscus; and that the compression of the surrounding abdominal muscles is the principal support of the liver, as it is of the other viscera.

The BROAD LIGAMENT* of the liver is formed by two lamina of the peritoneum, connected by their cellular membrane, descending from the middle of the diaphragm and point of the sternum to the convex upper surface or dorsum† of the liver. This ligament is broadest where it passes down from the point of the sternum to the fossa umbilicalis; but as it retreats backward it becomes narrower, and is united to the coronary ligament near the passage of the vena cava. This circumstance, with the curve which it naturally takes on the surface of the liver, gives it the shape of the falx, as it is formed by the dura mater.

LIGAMENTUM TERES. The round ligament of the liver is the firmer ligamentous-like cord, which may be traced from the umbilicus along the peritoneum into the duplicature of the broad ligament, and into the fossa umbilicalis. It is formed by the degenerated coats of the great vein which brings the florid blood from the placenta into the veins of the liver, and from thence conveys it into the right side of the heart of the fœtus‡.

THE CORONARY ligament of the liver is formed in consequence of the attachment of the liver to the diaphragm. The attachment is of course surrounded by the inflection of the peritoneum from the diaphragm to the liver. It is called the coronary ligament, though it has been observed, that this attachment of the liver is not circular, but of an oval, and very oblong shape. It appears, that it is this close adhesion of the liver to the diaphragm, which is the occasion of the sympathy of the diaphragm in disease of the liver, and the cause of the pain felt in the shoulder and neck from inflammation, and suppuration in the liver, in consequence of the course and connections of the phrenic nerve.

The LATERAL LIGAMENTS are formed by the peritoneum

* Ligamentum latum suspensorium, falciforme.

† See Plate I. of this volume.

‡ See vol. ii. p. 106. and Plate, p. 107.

continued laterally. The right lateral ligament, like a mesentery, attaches the right and great lobe of the liver to the diaphragm, and the left lateral ligament connects the left lobe with the diaphragm, and with the œsophagus and spleen.

FORM AND DIVISIONS OF THE LIVER.

The liver is convex and smooth on the upper surface; concave and more irregular on the lower part; thick and massy behind and towards the right side; but anteriorly and toward the left side it is thin, and has an acute edge, so that it lies smooth over the distended stomach.

GREAT RIGHT AND LEFT LOBES OF THE LIVER.—The first great division of the liver is marked on the convex surface by the broad ligament; which running back from the fossa umbilicalis divides it into the two great lobes, the right and left. When the concave surface of the liver is turned up, we see the same division into the right and left lobes by a fissure which runs backwards.

It is on this lower surface of the liver that we have to mark the greater variety of divisions in this viscus. Farther, it is on the right lobe that those eminences are to be observed which, with the indentations and sulci, give some intricacy to this subject.

LOBULUS SPIGELII*.—The lobulus spigelii is betwixt the two greater lobes, but rather belonging to the right great lobe. From its situation deep behind, and from its having a particular papilla-like projection, it is called lobulus posterior, or papillatus. To the left side it has the fissure for the lodgment of the ductus venosus; on the right, the fissure for the vena cava; and above, it has the great transverse fissure of the liver for the lodgment of the cylinder of the porta: obliquely to the right, and upwards, it has a connection with the lower concave surface of the great lobe by the processus caudatus, which Winslow calls one of the roots of the lobulus spigelii. It is received into the bosom of the lesser curve of the stomach.

LOBULUS CAUDATUS†.—This really deserves the name of processus caudatus, for it is like a process of the liver, stretching downward from the middle of the great right lobe to the lobulus spigelii. It is behind the gall-bladder, and betwixt the fossa venæ portarum and the fissure for the lodgment of the vena cava.

* *Lobulus posterior—posticus—papellatus.*
† Processus caudatus.

Lobulus anonymus* is the anterior point of the great right lobe of the liver: or others define it to be that space of the great lobe betwixt the fossa for the umbilical vein and the gall-bladder, and extending forward from the fossa for the lodgment of the porta, to the anterior margin of the liver.

Sulci, and depressions of the liver.—On the lower surface of the right lobe there may be observed two slight excavations, formed as it were by the pressure of the colon and of the kidney. On the lower surface of the left lobe there may also be observed depressions answering to the convexities of the stomach and colon. But these are only the slighter irregularities which might pass unnoticed. There are, besides these, deep divisions which pass betwixt the lobes and lobuli, and indeed form these eminences.

Umbilical fissure†.—From the anterior point of the two lobes there passes backwards to the left side of the lobulus spigelii a deep fissure, which in the fœtus gives lodgment to the umbilical vein, and which in the adult receives the round ligament, where it is about to terminate in the left division of the vena portæ. The back part of this fissure gives lodgment to the ductus venosus in the fœtus. This fissure divides the liver into its two right and left divisions, and upon the right side joins the transverse fissure.

The transverse fissure is that which passes above the lobulus spigelii, and lobulus quadratus; the processus caudatus, and the lobulus lobi sinistri. It is in this fissure that the great transverse division of the vena portæ lies.

The posterior fissure‡ gives lodgment to the ductus venosus. It is a division in the posterior margin of the liver betwixt the left lobe, and the lobulus spigelii, and great lobe on the right. Sometimes, instead of the fissure or sulcus, there is a canal, as it were, in the substance of the liver.

The fourth great fissure, is that for the lodgment of the vena cava. It sometimes is called, in contradistinction to the last, the right fissure, or the fissura venæ cavæ. It is a large deep division betwixt the lobulus spigelii and the back part of the right lobe, for receiving the vena cava as it passes up upon the spine.

The gall-bladder being sunk in the substance of the liver, the pit or excavation which receives it has been considered improperly as a fissure or fossa§. There likewise occur irre-

* Lobulus accessorius—anterior—quadratus.

† Horizontal fiſſure, foſſa longitudinalis, longa anterior.

‡ Or ſulcus ductus venoſi, the left fiſſure.

§ It is generally called, *fovea fellis*, or *vallicula veſiculæ felleæ*

gular fissures in the substance of the liver, which are like the cuts of the knife, and hold no regular place.

OF THE VESSELS OF THE LIVER, AND OF THE CIRCULATION OF THE BLOOD THROUGH IT.

There belong to the liver five distinct systems of vessels: these are, the vena portæ; the arteria hepatica; the vena cava hepaticæ; the lymphatics; and the biliary ducts*. These, with the nerves, form a very intricate system of vessels, but a lesson of the most particular importance to the physician. Before speaking of the connections which these vessels constitute with particular parts, or with the entire system, we shall take a strictly anatomical view of their origin and course.

THE VENA PORTÆ.

This vein is divided into two parts; that which belongs to the intestines, and which, ramifying on the mesentery, receives the blood of the mesenteric arteries; and that part which branches in the liver, and distributes there the blood which it has received from the arteries of the membranous viscera. Even from this division we see that the vena portæ has a very particular distribution; that while it is collecting its branches from the spleen, stomach, and intestines, like the veins in the other parts of the body, into a trunk, this trunk, instead of leading directly to the heart, or uniting with other veins in their course to the heart, enters the liver, and, like an artery, spreads into minute ramifications; hence it is called the vena arteriosa. It resembles an artery in this also, that it has no valves like other veins.

To be more particular; the vena portæ takes its origin from the extreme branches of the cœliac, upper and lower mesenteric arteries. The roots of the portæ answering to these arteries are the splenic vein; the gastro-epiploic vein which runs upon the great arch of the stomach; the mesenteric vein returning from the small intestines; and the right and middle colic veins, and internal hæmorrhoidal vein and left colic returning upon the mesocolon. These answering to the three great branches of the abdominal aorta, pass obliquely upward in three great divisions, and unite with some lesser veins, as the coronary and smaller veins of the stomach, and pancreatico-

* And we might add, the arteries of the outer membrane of the liver which arife from the internal mammary, phrenic, epigaftric, and even the fpermatic arteries.

duodenalis. The trunk of the vena portæ is now involved in the irregularly reticulated web of the hepatic vessels, arteries, veins, glands, lymphatics, nerves, and biliary ducts, with their cellular membrane. It passes upward somewhat obliquely to the right; and enters the PORTA* or the sinus betwixt the processus caudatus and lobulus spigelii.

When the vena portæ has entered the liver, it divides into two great branches, which running directly transverse, and being of large capacity, are sometimes called the cylinder of the vena portæ. Of these two great branches of the vena portæ within the liver, the right is greater in diameter, but shorter:† it ramifies in the great right lobe of the liver. The left is longer considerably, and filling the transverse fissure, it is reflected up into the umbilical or horizontal fissure, and is given to the left lobe, to the upper and more anterior part of the right lobe, viz. lobulus anonymus, and to the lobulus spigelii.

The minute ramifications of the vena portæ every where pervade the substance of the liver, and inosculate with the veins of the surface belonging to the peritoneal coat. The blood of the vena portæ, after secreting the bile, is received into the extremities of the venæ cavæ hepaticæ.

ARTERIA HEPATICA.

For the course of this artery from the root of the cœliac artery, to its entrance into the liver, see vol. ii. p. 257. and 259. The arteria hepatica and the venæ portæ are supported by the same sheath, the lesser vessel encircling the greater, like a tendril. While they have distinct functions, both terminate in the same returning veins: that is to say, whether we admit that one or both open into the biliary ducts, yet they have the same relation to the venæ cavæ hepaticæ which the arteries of the other parts of the body have to their returning veins.

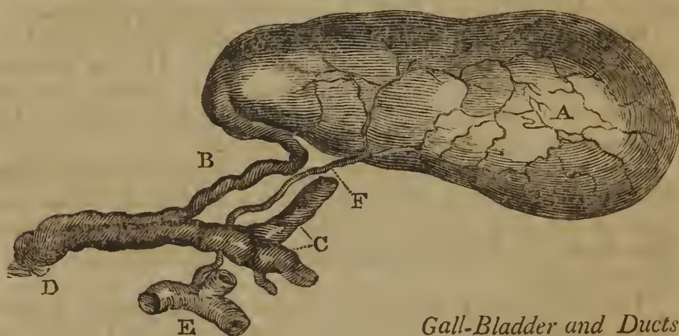
VENÆ CAVÆ HEPATICÆ.

We have seen, that the right auricle of the heart is close to the diaphragm above, and that the liver adheres to the lower surface of the diaphragm. We have also found that there was a groove in the back part of the liver for the transmission of the venæ cavæ abdominalis. Now as the venæ cavæ ascending from the lower parts of the body to the heart is perforating

* Sometimes it has been found divided before entering the liver. It has been alſo found to divide into three branches, in which caſes, ſays Haller, two go to the left ſide.

† Into this branch ſometimes the vein of the gall-bladder enters.

the diaphragm, it is joined by two large veins from the liver, which, from their size and form, being the returning veins of the liver, are termed in general the venæ cavæ hepaticæ. These veins sometimes pierce the diaphragm along with the cavæ abdominalis, so that there is to be observed one large perforation in the diaphragm, but generally they pass the diaphragm close to the great vein, but so that there are three openings in the diaphragm. When these hepatic veins are traced into the substance of the liver, they are seen to be gathered together from all parts of the liver in two, or sometimes three great branches. The communication betwixt the vena portæ and the venæ cavæ hepaticæ are so free, that several anatomists have imagined a peculiar and more immediate communication of their branches than holds in other parts of the body betwixt the arteries and veins ; a circumstance which appeared to them the more necessary, considering the lesser impetus with which the blood flows in the vena portæ than in the arterial system.



Gall-Bladder and Ducts.

BILIARY DUCTS.*

The last subdivision of the substance of the liver, or acini, as we shall presently find, is supplied with a branch of the venæ portæ, arteria hepatica, and venæ hepaticæ. With these there is also seen a minute ramification of the excretory duct of the liver. These last minute branches are the roots of the

* *Explanation of the plate of the gall-bladder.*

A The gall-bladder.
B The cystic duct.
C The hepatic duct.
D The common duct.
E The hepatic artery.
F The cystic artery coming off from it.

biliary duct; which running into each other, form trunks resembling the branches of veins, and which attaching themselves to the vena portæ, form the greater trunks, answering to the right and left side of the liver. These two divisions of the hepatic duct approaching each other, unite (C), while they are attached to the right branch of the vena portæ. Their union constitutes the hepatic duct, or ductus choledochus.

When the duct of the liver has advanced a little way from the transverse fissure, it is joined by the CYSTIC DUCT (B), or perhaps we should rather say, considering the use of the cystic duct, that it is reflected from it at an acute angle to the right side. The DUCTUS CYSTICUS is much smaller than the hepatic duct; and is somewhat curved in the direction towards its expansion into the gall-bladder; for there it takes a very sudden turn downward, as is seen in the marginal plate.

The hepatic duct, after being joined by the cystic duct, continues its course under the name of ductus communis choledochus, or common duct.* Now become somewhat larger, it takes its course under the head of the pancreas to the back part of the duodenum, about five inches from the pylorus.

Before it enters the gut, or more generally while included in the coats, it is joined by the pancreatic duct. Having pierced the muscular coat, it runs for some time in the cellular coat, in the length of the gut, and then opens upon the eminence of a considerable valvular plica of the inner coat.

This hole is regularly limited, and by no means equal to the diameter of the duct, either where it is contained within the coats of the gut, or in its course from the liver to the gut. Sometimes the hepatic and pancreatic duct open by distinct perforations.

The outer coat of these ducts is smooth and strong;† within this a cellular and nervous coat is described,‡ and muscular fibres imagined; but the inner coat is worthy of attention. It is reticulated in such a way, that a probe pushed up the duct is catched by their valve-like action.§

GALL-BLADDER.

We have already noticed, that the gall-bladder is attached to the lower surface of the right lobe of the liver, and partly bu-

* Ductus choledochus, hepatico cyfticus, (D.)

† Although this coat refifts, in a confiderable degree, the diftention of the duct, when blown into or injected, yet the whole are fometimes fo diftended as to admit the thumb. But this is rather to be confidered as growth and enlargement, than diftention.

‡ By Haller.

§ Thefe I have feen miftaken for actual obftructions.

ried in its sinus: it has sometimes occurred that it was merely suspended to the liver by a membrane like a mesentery. It is a bag of a pyriform shape; its greater end or fundus is contiguous to the colon; its lower end or neck to the duodenum. It has been found wanting altogether*. It is generally of a size to contain an ounce, or an ounce and a half of bile.

The coats of the gall-bladder are the outer peritoneal coat†; a middle cellular coat, what from its analogy to that of the intestines we should call vascular coat; and an inner coat. In the intermediate coat muscular fibres have been looked for with great eagerness, but none have been demonstrated, although a conviction remains that there are muscular fibres in the composition of the coats of the gall-bladder. This coat gives form, limit, and strength to the gall-bladder. The third or inner coat is formed into innumerable rugæ, so as to take a cellular or reticulated texture. These loculi, as we may call them, thus formed by the duplicature of the internal membrane, are of considerable variety of shape, square, round, or triangular. These rugæ, and the whole internal membrane of the gall-bladder, have a beautiful and minute net-work of vessels upon them; and in these cells there can be little doubt that there are small mucous folicules, or pores, or an exudation from extreme vessels, whose discharge sheaths the surface from the irritation of the acrid bile. The extreme degree of vascularity and reticulated texture of this inner coat of the gall-bladder is not apparent before the sixth or seventh month of the fœtus, and then it takes a peculiar texture in preparation for the reception of the secreted bile.

Towards the opening of the bladder into the cystic duct the rugæ take a semilunar figure, and seem to have a valvular action, in at least so far that they seem intended to give a degree of difficulty to the passage of the bile. The same structure of the internal coat prevails in the cystic duct.

However strange it may appear to one, considering the relation of the liver as a gland to its ducts, and to the gall-bladder as a receptacle of the bile, an opinion was entertained that the bile of the gall-bladder was secreted by its own coats, and that it was of a different nature from the bile conveyed from the substance of the liver. Without further argument it is

* In which caſe the dilated ducts in their courſe would ſeem to have been capable of retaining a quantity of bile ready to be evacuated into the inteſtine. A double gall-bladder has ſometimes been found.

† Like the peritoneal coat of the liver, it ſeems to poſſeſs very diſtinct veſſels from the vaſcular coat below. "Si itaque ea, a reliquis membranis ſolvitur expletis antea materia quadam colorata vaſis, ab arteria hepatica et vena portarum venientibus; videmus *eam* ne minimum quidem accipere ſurculum quo ornantur *nervea* et *vaſculoſa*." Annotationes Acad. F. Aug. Walter, p. 57.

sufficient to say, that when the cystic duct is tied, or when it is preternaturally obstructed, there is no bile secreted into the gall-bladder*.

From the connections of the gall-bladder, and from the consideration of the whole anatomy, there can remain no doubt that the gall-bladder is a mere receptacle, reserving a sufficient store of this fluid for the due change to be performed upon the food: that as the stomach is not at all times loaded with food, nor the chyme and fluid from the stomach incessantly passing through the duodenum, neither is the bile at all times running from the gall-ducts. On the contrary, as the stomach is emptied of its contents at stated intervals, there seems to be a provision for a quantity of bile being evacuated from the receptacle and ducts proportioned to the food, and while it is passing the duodenum. Whether we should conceive that this is a necessary consequence of the retention of the bile in the gall-bladder, or a wise provision of nature, I am uncertain; but it appears, that the longer the bile is retained, or the longer the fast and the deficiency of food in the duodenum, the more acrid and inspissated is the bile, and the greater also in quantity. This inspissation of the bile takes place in consequence of the activity of the lymphatics, which ramifying on the coats absorb the thinner part of the bile.

Further; I cannot look upon the rugæ and cellular structure of the inner coat of the gall-bladder in any other light than as the means of increasing the surface, and exposing the bile to a further absorption of its watery parts than otherwise would take place.

The gall-bladder is supposed by some to be emptied by the general pressure of the abdomen; an opinion founded on a mistake, which a very little consideration might correct. Others think that the stomach, or duodenum, or colon, being distended by the food, compress and empty the gall-bladder; while others with more apparent correctness allege, that it is emptied in consequence of a consent of parts. With the latter I would confidently affirm, that as the aliment passes the duodenum, the bile follows apace, either from the alternate contraction and relaxation of the duodenum occasioning a relaxation of the orifice of the ducts, or more probably from the ducts being excited, as the salivary glands are excited by the presence of sapid bodies in the mouth. By want and hunger,

* Were there no other proof of the gall-bladder being merely a receptacle, and not in any degree for fecreting the bile, the courfe of its veins (which run into the vena portæ) would be fufficient indication. If they had returned the blood from having performed the fecretion of the bile, they would have dropt into the cava, and not into the portæ.

on the contrary, the gall-bladder is allowed to distend: there is no call for its evacuation.

Experiments would even teach us, that the gall-bladder has not the same irritability excitable by stimuli applied to the coats, as the stomach, intestines, or bladder of urine; which is a proof that, like the iris, and many other parts of the body, its action is roused more powerfully by the stimulus of sympathy and consent of remote parts, than by the distention of its coats; whereas the intestines and bladder have it in their constitution to be excited to contraction by simple distention.

From experiments it would appear, in confirmation of what is here alleged, that while the food is in the stomach little bile is discharged; but that it flows when the matter is passing the duodenum, so that a great quantity is then formed in the gut. On the contrary, in a state of want and hunger, the gall-bladder is greatly distended, and yet little bile flows from it; although it is not only more accumulated, but more acrid and bitter*.

The gall-bladder is not destitute, however, of irritability and the power of contraction; for it would appear from many cases that, like the urinary bladder, it contracts upon concretions, and becomes thick in its coats.

The retention of the bile, surcharging the ducts, and distending the gall-bladder, and the sudden discharge of accumulated bile, and the irregularities of its course when influenced by disorder of the viscera, are the source of the most severe and distressing symptoms†.

In the dead body we see the colon and duodenum, or whatever parts lie in contact with the gall-bladder, stained with bile; but this evidence of transudation which is found in the dead body, is not seen in the living; while the stain from the bile is observed to be deeper and more extensive in bodies long dead. It is therefore another example of the peculiar properties inherent in the living fibres, that no transudation is allowed; but that the fluids, which appear as if exuding from the living surfaces, are discharges from organic pores, or from the extremities of vessels.

OF THE MINUTE STRUCTURE OF THE LIVER.

The liver is firmer and dryer in some degree than any of the other viscera; the intexture of membrane is weak, and in

* Anat. generale de Xav. Bichattom. iv. p. 6 5.

† We have one example of this in a late Treatife on the Difeafes of the Bowels of Children, by Dr Cheyne: an effay moft particularly ufeful in its object; and the reafoning of which is founded on anatomical obfervation, fupported by facts, and deductions from practice.

consequence the substance of the liver is friable and easily torn. When cut or torn, it seems for the greater part vascular; or it displays the mouths of innumerable ducts and vessels, and, after a minute injection, the blood-vessels seem to pervade every particle, even when examined with the microscope.

This texture of vessels, in which we may say the substance of the liver chiefly consists, is surrounded with a delicate membrane, the continued peritoneum. It retains the character of peritoneum, in being a simple membrane, whitish, and a little pellucid. In this membrane minute arteries and veins ramify, which are unconnected with the internal system of vessels, and in the close cellular membrane beneath it the lymphatic vessels take their course.

When a section is made of the liver, the vessels may be thus distinguished: the ducts by the thickness of their coats, and their yellow colour; the arteries by a less degree of thickness, and a more resisting elasticity; the branches of the vena portæ and the cava hepaticæ by the thinness of their coats, of which those of the latter are considerably the weaker.

With the investiture of the peritoneal coat of the liver even the vascular tissue of the body of the liver has no communication by vessels*. It is therefore considered as an organ of a peculiarly distinct organization. By the proofs from anatomical injections we are informed, that there is a free intercourse through the extreme branches of all the five systems of vessels in the liver. From minute injections, and the trying and making of sections in the liver, there seems no likelihood of gaining information of the structure and connections of these vessels. Walther, who seems to have examined more methodically and minutely than any other anatomist in any age, could make no distinction of parts. In whatever way he made his sections, whatever system of vessels he filled, whether the whole vessels or each separately, he could not ascertain the direction and course of any particular vessel, nor its inosculations, but all was obscure, and as if constituting one chaotic mass. In wet preparations, however, he observed, that the extremities of the branches of the hepatic artery opened into the vena portæ: that the branches of the vena portæ had a double termination: that some of them, by a sudden turn and serpentine course, terminated in the branches of the venæ cavæ hepaticæ†; while others were seen to terminate

* Soemmering. Walther, loc. cit. &c.

† I ſhould imagine that in this he might have been deceived by the leſſer branches of the portæ (filled with injection) opening into the ſide of the larger

or open into the biliary ducts. Further he observed, that in all the branches of the vena portæ there was a peculiar compressed appearance which distinguished them from all the other vessels of the viscus.

There have been observed, by almost every author, intersections of the intimate membrane of the liver, which divides and subdivides the fasciculi of vessels. These are, however, obscure divisions. The last perceptible divisions have been called ACINI*; and they are rather presumed than directly proved to have in their composition an extreme ramification of the several vessels of which the liver consists†.

We have seen Malpighi conceiving that these bodies were simple glands collected on the ramifications of the vessels; that they were little vessicles; and that from them the pori bilarii took their origin. In this opinion he was successfully opposed by Ruysch, who affirmed that these were vascular; and in this he has been supported by Albinus. It would in truth appear, that the description of these partitions of the substance of the liver, and the ultimate subdivision of it unto these little grains, about which there has been so much speculation, is not founded in an accurate observation, and that there are neither criptæ, hollow or cellular, nor little bodies made up of convoluted arteries, but the minute parcels of vessels which are observable may be called acini, in the strict definition which has been given in the introduction.

Finally, Ruysch's opinion may be given in these words: (Epist. ad Virum Clar. Ner. Boerhaave, p. 69.) "Sed nolo diutius tergiversari, fateor ergo, quod, quando primo incipiebam me exercere in anatomicis, videbam tunc quidem, quod in jecore humano se ostendebant acinuli parvi innumerabili numero, quæ tum temporis appellabantur glandulæ; nam nemo cogitabat aliter sed manet sola jam hæc questio, an acinuli hi hic herentes sint glandulæ simplicissimæ, foliculi cavi cum emissario an quid aliquid? dico nemo demonstravit illos tales esse ut hic assumis. Imo vero facile jam erit demonstrare, acinos hos cum criptis antea pertractis nihil commune habere: quia oculis nostris non apparent ut membranulæ cavæ & quia etiam non habent emissarium. Sed componuntur tantum ex extremitatibus ultimis vasculorum sanguiferorum unitis in formam spheræ rotunditatis, neque, quantum possum videre etiam membranula aliqua sua singulari circumambiuntur."

trunks; and that there is no fuch termination of the hepatic arteries in the fides of the vena portarum, fo that their open mouths are difcernable.

* See the definition in the introduction to the prefent volume.

† Acinos nemo rejicit, ne Ruyfchius quidem, fed de interiori fabrica difputatur. Haller.

OF THE SECRETION OF THE BILE.

Upon reviewing the whole system of the liver the peculiarities in the vena portæ strike us the most. It occurs to us that the passing of this profusion of blood retrograde into the liver, with the slow motion peculiar to venous blood, and after having gone the circulation through the intestines, and consequently lost those properties which constituted it arterial blood, is a provision for the secretion of the bile. It is almost universally concluded, that the secretion of bile is made from the blood of the vena portæ.

But as we see that this blood distributed by the branches of the vena portæ in the liver must be so far exhausted as to become incapable of all the uses accomplished by the arterial blood in other glands, that although the vena portæ be peculiarly adapted to secrete the bile, it is not capable of supplying the nutrition and the energy to the substance and vessels of the liver, there is a necessity for arterial blood being sent to this gland through a branch of the arterial system. We have had occasion to remark, that no part retains its function in vigour, nor the living properties which are inherent in it, while the whole œconomy is entire and correct, unless the blood be circulated through it. Therefore it would appear necessary that the arteria hepatica, a branch of the aortic system, should also be bestowed upon this viscus. These arteries perform the same office here in the liver that the bronchial arteries do in the lungs, or the coronary arteries in the heart, or the vasa vasorum in the great vessels. The pulmonic artery carries venous blood into the lungs, which having returned from the circulation of the body cannot send off smaller branches to supply the membranes and vessels of the lungs, it is necessary that for this purpose branches of the aortic system shall enter the lungs. Again, in the heart the blood contained in its ventricles is incapable of supplying its substance, or the blood coming through the calibre of the great vessels cannot be the means of ministering to their active powers, but for this purpose the vasa vasorum are distributed through the coats of the vessels. These vessels therefore bear an analogy to the arteria hepatica in the liver.

We must not however suppose that this scheme of the action of the vascular system of the liver, however rational and simple, will be universally allowed. Indeed there are circumstances which seem to stand in opposition to it. Of these, the most interesting is the case of unusual distribution

of the vessels of the liver communicated by Mr. Abernethy of St. Bartholomew's hospital.

The subject was a female infant which was supposed to be about ten months old. Among other varieties it was observed, that the branch of the cœliac artery distributed to the liver was larger than common, and exceeded by more than one third the usual size of the splenic artery. This was the only vessel which supplied the liver with blood for the purpose of either nutrition or secretion. The vena portarum was formed in the usual manner, but terminated in the inferior cava nearly on a line with the renal veins. The liver was of the usual size, but had not the usual inclination to the right side of the body: it was situated in the middle of the upper part of the abdomen, and nearly an equal portion of the gland extended into either hypochondrium. The gall-bladder lay collapsed in its usual situation. It was of a natural structure, but rather smaller than common. On opening it there was found in it about half a tea spoonful of bile. The bile in colour resembled that of children, being of a deep yellow brown, and tasted like bile, but it was not so acridly bitter and nauseating as common bile.

Mr. Abernethy remarks upon this case, that when an anatomist contemplates the performance of biliary secretion by a vein, a circumstance so contrary to the general œconomy of the body, he naturally concludes that bile cannot be prepared unless from venal blood; and he also infers, that the equal and undisturbed current of blood in the veins is favourable to the secretion; but that the circumstances of this case in which bile was secreted by an artery prove the fallacy of this reasoning*.

We may further observe on this case, that it does not prove the bile in the natural œconomy to be secreted by the arteries and not by the vena portæ; for the artery here was unusually large, so that it performed a function in this instance which it does not usually perform. On the contrary, had the artery been of the usual size, we might then have concluded that the vena portæ was distributed to the liver to serve some lesser use in the œconomy of the system, and that it did not secrete the bile.

The liver, it is said, was of the ordinary size. Now as the bulk of the liver is, in its natural state, made up of the dilated veins, it is some proof of what I should imagine had taken place here, that by some provision of the vessels the arterial blood had been diffused, and the celerity of its motion checked

* See Mr. Abernethy's caſe, of uncommon formation of the liver. Phys. Tranſactions.

previous to its ultimate distribution. Nay, it may have opened into the branches of veins answering to the extremities of the vena portæ.

In the deficiency of the due acrid and bitter state of the bile, there is in this case evidence that the bile formed from the arterial blood is still unfit for the perfect secretion. I conceive this to be countenanced by the circulation of the blood in the liver of the fœtus, and by its effects upon the secretion. We have seen that almost the entire gland is supplied with arterial blood returning from the umbilical vein; and the natural deduction from this is, that it is the cause of the less stimulating quality of the bile in the fœtus.

I conclude, that this singular and interesting case may strengthen the opinion which some have entertained that the extreme branches of the hepatic artery pour blood into the extremities of the vena portæ previous to this formation of the bile by these veins ; but it still leaves us with the general conclusion that the peculiarities in the distribution of the vena portæ are a provision for the secretion of the bile, and that the branch of the aortic system, the hepatic artery, is otherwise necessary to the support of the function of the liver.

Finally, as to the use of the liver independently of the secretion of the bile, we must lay aside the opinions mentioned by Haller that it supports the diaphragm, protrudes it up in expiration, and receives the contraction of it equally in inspiration, so as uniformly to compress the other abdominal viscera ; or that it foments and cherishes the stomach by the heat of its blood. These are at least as bad as the theories of the ancients mentioned in the beginning of this section. Haller's failing is the promiscuous admittance of all facts and every kind of theory, with a timorousness and indecision in giving his own opinion.

There is another remark of Haller which deserves attention. When I reflect, says he, that there is no bile required in the fœtus, there being no food received : when again I see that the liver is of great size in the fœtus, and not small like the lungs, which are destined to an operation in the œconomy after birth, I cannot but suspect that it has some other use in the fœtus than the secretion of the bile. If the umbilical vein had opened directly into the cava, he thinks it would have returned with too great an impetus upon the heart, and would by its preponderancy have retarded the return of the blood from the lower extremities. He thinks that the liver is useful in breaking and weakening the impulse of the blood from the umbilical vein ; that it is a guard to the right auricle, which would be otherways endangered by the rapid flow of the blood. Now surely

the liver is much less able to stand the impulse of the blood than the heart; and yet there is no provision for the breaking of the force of the blood in the liver. Further, there is a direct duct of communication leading to the heart. There is no reason to believe that the umbilical vein carries back the blood with greater force than any other returning vein: on the contrary, from its size and the length of its course it is natural to suppose the motion of the blood in it to be very slow and equable.

We must look upon the peculiarities in the circulation of the blood in the liver of the fœtus as a provision against the secretion of stimulating bile; for when the child is born and the circulation altered, bile is formed more abundantly, and becomes the stimulus to the whole abdominal viscera, rousing them to new action. As to the comparison which Haller has made between the state of the liver and that of the lungs, it is evident that the latter, though small in bulk, are fully formed, and want only inflation to complete their function. On the contrary, in the liver of the fœtus the vessels are necessarily distended with blood, to give them the size requisite for this future function; but that blood, either from its qualities or from the easy and direct passage it has into the heart, does not secrete the bile in quantity and quality so as to stimulate the ducts and intestines, as in the adult circulation. If it did, we should not see the alimentary canal of the fœtus loaded with matter, and yet not stimulated to action, but in a state of inactivity and torpor.

SECTION II.

OF THE PANCREAS.

The Pancreas is a gland the largest of those which have been called conglomorated, that is, distinctly consisting of lesser parts united. It is of a long form like a dog's tongue, and lies across the spine, and behind the stomach. Its excretory duct opens into the duodenum.

The pancreas is confined betwixt the two lamina of the mesocolon, and it is united to them by a loose cellular membrane; it lies before the great mesenteric vessels: its small extremity touches the spleen, and is near the capsuli of the left kidney: but towards the right extremity it increases gradually in massi-

ness until its head lodges upon the duodenum. It is like the salivary glands in its appearance, consisting of lobules successively smaller and smaller; and it also resembles them in the manner in which its duct is formed. The duct* begins towards the left extremity by exceedingly small branches; these running together form a middle duct, which taking a serpentine course towards the great extremity, and increased by the accession of the lateral branches in its course, becomes nearly of the size of a writing quill. Now approaching the duodenum it unites to the biliary duct, and opens along with it into the duodenum. A valve has been described as in the extremity of the pancreatic duct, but it is certainly incapable of the action of a valve, as the bile has been found to have gone retrograde into the trunk of the pancreatic duct. Sometimes there are two pancreatic ducts, but more frequently the part of the gland next the duodenum, and which is called the round head of the pancreas†, has an excretory duct peculiar to itself, which either opens into the duodenum separately from the main duct, by piercing the coats of the intestines nearer the stomach, or sometimes opens further down.

De Graff, Ruysch and many others have made experiments to discover the nature of the secretion from the pancreas. Tubes were introduced into the ducts, and bottles were appended to them in living dogs, so as to catch the pancreatic fluid: it was found ropy, insipid, and like the saliva. It has therefore been concluded, from the colour, structure, ducts, and secretion of the pancreas having so strict a resemblance to those of the parotid and submaxillary glands, that it is of the nature of the salivary glands of the mouth. The general opinion has been, that it is useful in secreting a fluid which dilutes and moderates the acrimony of the bile. More accurate chemical examination of the pancreatic fluid has not been made, or has not been successful in showing any peculiarity in it.

Considering the pancreas as a salivary gland, how great must be the quantity of fluid poured out by it, if, as we are entitled to do, we take the analogy of the parotid submaxillary and sublingual glands. These salivary glands, although they may be said to surround all the jaws from the zigomatic process on either side, are nothing in massiness and size to the pancreas. Again, the pancreas is most plentifully supplied with blood-vessels. Besides lesser branches of arteries, the pancreatico-duodenalis gives two branches, which take an ex-

* Ductus Virſungi.

† This is what Winſlow calls the little pancreas, and is ſometimes schirrous ſo as to compreſs the biliary ducts.

tensive course through it, and are joined by other mesenteric twigs; and twigs proceed from the vessels of the stomach, and even from the hepatic artery; but more particularly we have to observe the large branches bestowed upon it by the splenic artery, where it takes its course close upon it.

While the masticators are working, the parotid gland pours out so great a quantity of saliva, says M. Helvetius, that it is inconceivable, and what I should not believe, had I not seen it in a soldier of the guards. A cut with a sabre in the cheek had opened the salivary duct: the wound healing on the inside of the cheek left a fistulous discharge from the parotid duct. When he eat, there flowed from this hole a great abundance of saliva, so that during dinner, which is not long in the Hotel Dieu, it moistened several napkins. How much must flow from all the salivary glands? How much from the pancreas, which is greater than them all collectively?

Like the biliary secretion it is probable that the contents of the stomach passing the duodenum, or the bile flowing from the biliary ducts, form the stimulus to the discharge of the pancreatic fluid; and as we see that the morsel in the mouth will quickly produce an almost instantaneous secretion and discharge of saliva, so we are led to conclude that the flow of pancreatic fluid may be as suddenly produced without the necessity of a reservoir, as in the biliary system. We naturally conceive that the effect of this fluid is to diminish the viscidity of the bile, and by diluting it to mix it uniformly with the food. There are however few facts to enable us to reason on the effects of the pancreatic fluid. If we give full credit to the experiments of Malpighi and Brunner we may conclude, that when the pancreas is taken away, the more acrid bile causes vomiting or voracious appetite by its stimulus. Schirrus of the pancreas has been found attended with a costive and slow motion of the intestines; which seems to contradict the result of these experiments on animals; but by the schirrosity and enlargement of the pancreas the biliary ducts may have been more or less compressed, and the retarding of the usual quantity of the biliary secretion might produce the slowness of the bowels.*

* According to the hypothesis of Silvius, the use of the pancreas was to supply an acid spirit or juice, and the biliary secretion being of the nature of an alkali, these two struggling together caused the separation of the chyle from the fæces. This good fight did not stop here, but these enemies being carried into the blood, continued their warfare in the heart itself. and lighted up the vital flame there.

Nay, if we believe the experiment of F. Schuly, (de Veteri Med.) this hypothesis was not without its proofs; for having tied in the portion of the duodenum of a living dog, where the pancreatic and biliary ducts enter, he saw the ebullition from this struggle of the acid and the alkali; and when he compressed the hepatic duct,

SECTION III.

OF THE SPLEEN.

The spleen is a viscus of an irregular, oval figure, and dark purple colour. It is attached to the great extremity of thé stomach. It is soft in its substance; and has the peritoneal coat very delicate. We should be glad could we say that it is of a parenchematous structure, for in truth little is known of its organization.

In treating of this subject we must be indulged in some speculation; and indeed it is priviledged ground; for the history of the opinions regarding the supposed function of the spleen is full of loose conjectures or wild hypothesis, and nothing is as yet certainly known of its use.

SEAT AND CONNECTIONS.

The spleen is seated in the left hypochondrium; above the left kidney; and under the protection of the false ribs; and of course it is under the edge of the diaphragm. It is connected with the stomach by the cellular membrane, by the omentum, and in a still more particular manner by the vasa brevia. It has also connections with the left extremity of the pancreas by cellular membrane, and the branches of the splenic vessels. Lastly, it has a firmer attachment to the diaphragm, by means of a ligament formed by the peritoneum.*

The spleen is of no regular figure. Where it is contiguous to the diaphragm it is uniformly convex: towards the stomach its surface, while it is hollowed out and concave, presents two sides, so that we say the whole mass is somewhat of a triangular form. The anterior edge of the spleen is notched with deep sulci; behind and at the upper part the margin is large and round.

The substance of the spleen is the most spongy, tender, and soft of the abdominal viscera; so much so that not only does the finger make an impression upon its surface, but it actually disorders and tears its vessels. After a successful injection the

the tumifaction of the inteftine fubfided; when he took off this compreffion it was again blown up. As this experiment has not fucceeded fince, as Haller obferves, Schuyl was probably deceived by the periftaltic motion of the inteftines.

* Yet the fpleen is very apt to change its fituation, or to fall down under the protection of the falfe ribs. It is liable to enlargement in afcites. From which circumftances it will not be wonderful if it is wounded in tapping for the afcites. See Monro on Dropfy.

whole seems made up of vessels; and if any thing like acini or globules are to be observed, the microscope will show them to be accidentally produced by the fasciculi of vessels. It has a strict resemblance to the substance of the placenta. The spleen is seldom smaller than natural; often greatly enlarged. I have seen it equal to the liver in size, and filling the whole left side of the belly. It has been frequently found thus enlarged, without any peculiar symptoms indicating such a disease during life. From its soft texture and great vascularity, like the liver, it has been found rent by blows and falls; and wounds here, as in the liver, by opening the large vessels are suddenly fatal. Sometimes it is hard and schirrous, and marbled in its colour. There is seldom suppuration in it. The spleen has been supposed to swell up and enlarge when the stomach is empty, and to be contracted when it is full. It has been observed, that it is large and spongy in those who have died a lingering death, or who have been long ailing: that on the contrary, it is smaller and firm in those who have died suddenly of a violent death.

We are informed, that the blood of the splenic vein is peculiar, insomuch that it does not coagulate like the blood in the other veins of the body*.

That which more than any other circumstance excites our attention, is the great size of the blood vessels of the spleen. Both the splenic vein and the artery are of great size in proportion to the bulk and weight of the spleen; and in their course they are particularly tortuous. I conceive we may also draw consequences from the distribution of their branches to the stomach (viz. the vasa brevia and left gastro epiploic) and to the pancreas. Its lymphatics are numerous. It is supplied with nerves, but has very little sensibility. It has no excretory duct.

OPINIONS REGARDING THE USE OF THE SPLEEN.

Of the various uses of the spleen, the lowest conjecture in respect to ingenuity or probability is, that like a sand-bath it foments the stomach, and promotes the process of digestion. This notion is perhaps not inferior in absurdity to that opinion which ascribed to the spleen the office of forming an acid juice, which being carried by the vasa brevia into the stomach, was supposed to excite the appetite†.

* With regard to this point I have no opinion, having hitherto neglected to examine the fact.

† I am miftaken in calling this the loweft in abfurdity. The fpleen has been confidered as the feat of the foul! the caufe of venereal appetite! the gland

It was a better conception that the spleen is the seat of melancholy; "that moping here doth hypochondria sit:" or of "laughter holding both his sides," of which the holding of the sides was an evidence. And again, since tickling the ribs is a demonstration of the effect from this excitement of the spleen*, that the growth of the spleen promotes laughter to such a degree, that it becomes a permanent silly simper impertinently excited. Nay further, we have authority for the excision of the spleen from those who are otherwise incurable in their propensity to laughter.

The following is a theory which has been very commonly received. A great quantity of blood is imported into the spleen with a slow motion, owing to its serpentine course. When the stomach is empty, the blood is received in a greater quantity by the spleen, where it has an opportunity of stagnating. Here the blood fomented, attenuated, and in a manner dissolved by the neighbourhood of the putrid fœces in the colon, enters upon the first steps of a begun putrifaction. By this resolving of the blood it is made more fluid, in which state it is returned by the veins, there being no excretory ducts. Now when the spleen is compressed between the distended stomach and the ribs, and the contracting diaphragm, the blood is pressed out from it in greater quantity and celerity towards the liver, mixing with the sluggish blood in the trunk of the vena portæ, replenished with the fat and oil of the omentum, it dilates it and prevents its stagnation and tendency to congeal. In short, the spleen has been supposed to be subservient to the function of the liver, and to the preparation of a watery (and subalkaline) fluid to the blood of the portæ. Another opinion has been, that it counterbalanced the mass of the liver seated to the right side of the belly.

Hewson entertained a theory regarding the use of the spleen which sullies his high character and reputation. He conceived that the spleen added the flat vessicle of the globules of the blood: his only observation in way of proof was, that he saw a few red globules returning by the lymphatics of the spleen: the effect, I have no doubt, of the injury of its substance, or of the compression of its vessels. It seems to me strange that

which formed the mucilaginous fluids of the joints! The atrabilis was received here concocted and tranfmitted to the liver. It drew forth and formed blood from the ftomach, &c. Other phyfiologifts, not contented with the theories prefented to them, and yet incapable of fuggefting others more likely, have very modeftly afferted that the fpleen was of no ufe at all.

* Rifus in liene fedes videtur ex effectu titilationis nataque in plurimis mortalibus rifum excitat. &c. Haller. His fober objection is, that tickling the right fide will do as well as the left.

such a man seeing the large splenic artery throwing its full tide of perfect arterial blood into the spleen, full of globules, complete in every respect, and again seeing a few globules carried back by the lymphatics, should imagine that this artery formed these few vessicles with which it was already so fully charged.

Of late years we have seen men endeavouring to raise themselves into notice by an attachment to the opinions of their departed patrons; by supporting those opinions; by holding, as they imagine, the proofs and illustrations of them in their possession: but seldom do we see the memory of great men honoured by such obsequies. The officiousness of Hewson's friends in promulgating his opinions has done no honour to his memory. They have attempted to support, on insufficient grounds, what he might have had the ingenuity to render plausible, and which are very far from honourable to his reputation, imperfect as they now appear.

I conceive the spleen to be an organ subservient to the stomach: and not only the constant attachment of it to the stomach in the human body, but the constancy with which it is found connected with the stomach in the lower animals, confirms the opinion. I regard it as a provision for giving the vessels of the stomach an occasional power and greater activity, enabling them to pour out a quantity of fluid proportioned to the necessity of the digestion. In the first place, let us examine the course and form of the splenic artery, and I think we shall find the great peculiarity of its size, and tortuous form, and strong coats, a provision for occasional great increase of power; while, if not roused by the peculiar sympathies which actuate it, it is of a form to retard and weaken the velocity of the blood. This is founded on these propositions:

1. The muscular power of an artery increases as it recedes from the heart; the elastic power diminishes.

2. An artery, the nearer it approaches to its final distribution, is the more immediately under the excitement and controul of the organ; is active when the organ is excited; is, relatively speaking, quiescent when that organ is not called by its sympathies to exercise its function.

3. An artery tortuous in its course has more muscularity and greater power of action than one which takes a straight course; but in proportion to the increase of power which it obtains by its increase of length in this tortuous and bending course, will these turns retard and weaken the force of the heart upon the extreme ramifications of the vessel.

Thus a tortuous artery is the means of increasing the velocity of the blood by its own action, but it makes the organ less dependent on the general force of the circulation. We ac-

cordingly find that in those organs where there is occasional activity alternating with a quiescent state, the artery is tortuous; and where there is an increase of force required in the circulation, there, the artery, from being straight in its course, becomes crooked and twisted in every way*.

From these remarks, we may be inclined to draw, from the tortuous figure of the splenic artery, a conclusion somewhat different from that which has hitherto been deduced. We may conclude that it is not the means of retarding the blood in its circulation, but of giving force to it. The splenic artery does not only ramify in the spleen, but it supplies all the left part of the stomach, and that great sacculated extremity in particular which receives the food, and in which the process of digestion is chiefly performed. My idea is, that when the stomach is empty, when there is no food in it to solicit the discharge of the gastric fluid, the blood circulates in a moderate degree in the coats of the stomach, and the spleen receives the surcharge of blood; but when a full meal is taken into the stomach, when the action of the gastric juice is required in great quantity, the action of the splenic artery is solicited to the vasa brevia and left gastro-epiploic artery, and thus a sudden flow of the gastric fluid is bestowed by the increased activity of the splenic artery. When again the contents of the stomach are fully saturated with the fluids from its coats, there is no longer an excited action of the splenic vessels, and the artery terminating in the veins, the spleen returns the blood to the liver. While the vessels of the stomach partake largely of the supply of blood, the arteries to the pancreas also receive some increase of activity; and even the blood of the vena portæ requires an additional activity.

We have seen that the stomach and intestines, the liver, pancreas, and spleen are combined in function, connected by the same system of vessels, mutually subservient to each other, and tending to the same end, the reception, digestion, and first stage of the assimilation of nutritious matter to the system. We leave this subject therefore until we can take up that of absorption and the lymphatic system, and pass to the kidney and viscera of the pelvis.

* This has been ſuppoſed the effect of the impulſe of the blood, but nothing can be more falſe. Let any one examine the artery of a limb when a great tumour is growing; the artery will be found tortuous to ſupply it. Again, in the aneuriſmal varix where there is a breach in the artery, and the blood finds a freer return to the heart, the artery will be found enlarged and tortuous in order to ſupply the lower part of the limb; while there is a quantity of the blood withdrawn from the circulation by the communication with the vein.

SECTION IV.

OF THE KIDNEY.

THE kidnies are distinct from those parts which have hitherto engaged us, as they secrete the urine, and form therefore the link betwixt the viscera of the abdomen and those of the pelvis; for though lying in the abdomen, they are more strictly connected with the parts in the pelvis. The structure of the kidney forms a very interesting subject of inquiry; because it is the field of dispute betwixt the contending parties regarding the structure of glands and the theory of secretion. It is chiefly from the kidnies that the facts are drawn in illustration of the opinions of Malpighi, Ruysch, and all the others.

FORM, SEAT, AND CONNECTIONS. The kidnies lie on each side of the spine; sunk as it were in the fat of the loins; attached to the muscles of the loins; and in part lying on the lower belly of the diaphragm; which last connection is the cause of the pain felt in respiration during inflammation in the kidney. The kidney lies betwixt the spine of the ilium and the lowest rib. The right kidney is placed somewhat lower than the left, which is owing to the great size of the liver on that side.

The kidnies are without the abdomen, that is to say, behind the peritoneum; for the kidney lying close upon the muscles of the loins, the peritoneum is merely stretched over it. This is the reason why calculi in the kidney have wrought themselves out by fistulæ in the loins; and it is the ground of the hazardous proposal of cutting into the kidney to extract calculi.

The adipose membrane surrounds the kidney, and forms a perfect capsule; for it is this which is sometimes in an extraordinary degree loaded with accumulated fat. Upon this capsule the cæcum is attached on the right side, the colon on the left, and betwixt the kidnies and the intestines there is a strict sympathy, which is apparent in the nephritic colic.

The figure of the kidney is that of an oval bent, or a little incurvated, so as to form a sulcus or general concavity to one side, while the other takes a greater convexity. By the concave surface of the kidney, which is towards the spine and great vessels, the arteries and veins and ureter pass in by the sinus round which the substance or glandular body of the kidney terminates abruptly.

The abdominal aorta and the vena cava lying close on the spine and near to each other, give off laterally the emulgen

arteries and veins. The renal or emulgent artery comes from the side of the aorta betwixt the upper and the lower mesenteric arteries: that of the left kidney has its origin a little higher than the right: and the aorta being on the left and the cava towards the right side of the spine, the left emulgent artery is shorter than the vein; the artery longer than the vein on the right side. Again, the aorta being more closely attached to the spine, the emulgent vein lies rather above the artery.

The vessels, and especially the arteries of the kidney, are very irregular in their number and form. Where they enter the body of the gland, they are accompanied with a capsule which continues with them to this final distribution. Sometimes a solitary vessel is seen making its exit by the convex surface of the kidney.

We have had occasion to remark on the nerves of the kidnies and their connection with the coverings of the testicle, and to notice their effect in producing numbness of the thigh and retraction of the scrotum in inflammation of the gland, when stones lodge in the pelvis or ureter.

Upon the subject of the sensibility of the kidney, however, we must be aware that disease, inflammation, suppuration, nay even total wasting of the kidney may take place without any indication from pain.

The excretory duct of the kidney is called URETER: it leads from the kidney to the urinary bladder. When we trace it into the kidney it is found to enter the navel-like sulcus of its concave side; here it is enlarged into a considerable sac which is called the PELVIS of the kidney. This is a kind of reservoir which, lying in the embrace of the solid and glandular part of the kidney, sends up several elongations almost like the finger of a glove, which receive into them the papillæ, the concentrated uriniferous tubes. These processes of the pelvis are called the COLICES OF INFUNDIBULI.

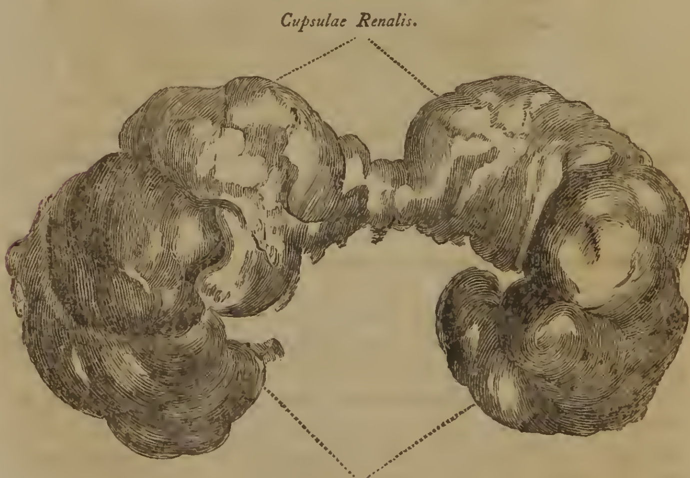
It may be observed, however, that the term pelvis is taken from the greater dilatation of the ureter within the gland, which is seen in brutes; and that in man it is not so remarkable, the ureter branching with only a lesser degree of the sacculated form into three or four divisions, and these into the lesser infundibuli.

The coats of the ureter are three in number; a dense outer coat; a middle coat, apparently consisting of circular muscu-

lar fibres, though this has been denied; and a smooth inner coat, (very improperly called villous,) which secretes a mucus to defend it from the acrimony of the urine. The ureters do not run in a direct course to the bladder of urine; they take a curving direction; are in some places irregularly dilated, as when they pass over the psoas muscle,* dropping deep into the pelvis, and getting betwixt the rectum and bladder they open obliquely into the latter.

MINUTE STRUCTURE OF THE KIDNEY.

The ancients, says Malpighi, contented themselves with the idea of a sieve, as conveying a knowledge of the manner in which the urine was drawn off by the kidney; that the fibres of its parenchematous matter attracted the serum of the blood; that the fibrous matter was perforated with innumerable foramina; or that the whole was a congeries of canals through which the urine was strained and drawn off. Malpighi set himself to refute these vague opinions by the minute examination of the structure of the kidney; and he seems to have known almost all that we now know. Though we do not acquiesce in his opinions regarding the final and minute structure, he describes accurately every part of the gland.



The Lobulated Kidnies of the Fœtus.

* When the bladder is contracted in consequence of a stone, or when it is dilated by obstruction, the ureters are dilated also; particularly in the first case. Whilst they are dilated, their coats become thickened, and their course is tortuous.

In the first place, when we examine the outward appearance of the kidney of the fœtus, as in this annexed plate, we observe that it is not, like that of the adult, smooth and uniform; but that it is tuberculated or lobulated; that it consists of distinct parts, or glands united together. Again, when we examine the kidnies of other animals, we find in several instances that the full grown animal retains this lobulated form. In short, it immediately strikes us that the kidney is not a uniform mass of glandular matter, but that it must resemble those glands which they call conglobate, and which consist of several compartments or distinct glands united together.

Accordingly a section of a kidney shows us that this is the fact.

Example of the Lobulated Kidney.

The * section of the kidney shows us these parts. First, we see towards the surface that which is called the cortical or

* *Explanation of the annexed plate.*

A B C D. The ſeveral diviſions of the kidney which give it the lobulated figure.

E E. The cortical part of the kidney, being the outer, and it is ſuppoſed, the ſecreting part.

F F. The tubular part of the kidney.

G. The papilla, or that part which projects into the calyx or diviſion of the pelvis.

H. The perceptible ducts in the point or apex of the papilla.

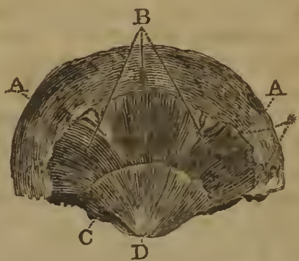
I I I. The other papillæ.

L. The point of one of the papilla which we ſee projecting into the pelvis.

M. The pelvis of the kidney.

N. B. This repreſents only one half of the kidney.

glandular part E. Secondly, striæ, converging towards the centre of the kidney, being what is called the tubular part of the kidney.* These tubuli are divided into fasciculi, taking a conical shape; and these converging unite at the apex; two or three of them united form the papillæ. The papillæ are generally ten or twelve in number, or even more in each kidney; their points are received into the extremity of the infundibula; they pour the urine into these tubes, and it is collected in the pelvis. Now when we examine one of these papillæ in a lobulated kidney, we find that it is the centre of one of these subdivisions. Thus,



A A. *Cortical Substance.* B. *Tubular part.*
C. *Papilla.* D. *Ducts.*

The papilla C is merely the continuation of the tubuli B; but it is that part which projects from the body of the kidney into the calyx; and although these divisions of the substance of the kidney are enumerated as three distinct parts, the cortical, tubular, and papillar parts, they are properly only two, the cortical and tubular parts.

Some however have made a new distinction, by asserting that a vascular part is to be observed betwixt the cortical and tubular or striated parts, as at *; but it is not the case; for although when we make a regular section of the whole gland, the mouths of some larger vessels will be observed betwixt the fasciculi of the urinary tubes, yet they are irregular ramifications tending to the outer cortical part, and not such as separate the tubular and cortical part, nor so regular as to be considered as one of the subdivisions of the kidney.

* Improperly medullary, sometimes STRIATA SULCATA. F F.

OF THE CORTICAL PART.

The external and cortical part of the kidney is by all allowed to be the secreting, or, as they rather term it, the secerning part of the organ. It was this part which the older writers considered as in a more particular manner to consist of a peculiar fleshy substance or parenchymatous matter. It is in this cortical matter that the glandular bodies described by Malpighi are supposed to be seated. The appearances which he describes are to be very distinctly seen in many animals; for example, in the horse's and cow's kidney; and are to be seen represented in these plates. But he asserted these bodies to be also observable in the human kidney; to demonstrate which he ejected a black liquid mixed with spirit of wine, by which the kidney becoming universally tinged, you may then see, he said, when you have torn off the coats of the kidney, small glands partaking of the colour of the arteries. These are the glands of the cortical part of the kidney, which Malpighi described as hanging upon the branches of the arteries like fruit upon the pendant branches, and round which the arteries and veins ramified and convoluted, like delicate tendrils, so as to give them the dark colour which they have.

Into these bodies he supposed the urine to be secreted, and from these bodies it was conveyed into the uriniferous ducts or tubular part of the kidney; but he acknowledges that the communication betwixt the ducts and glands is very obscure.

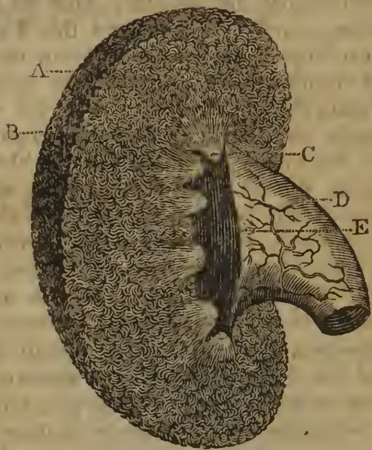
Ruysch and Vieussens held a very opposite opinion regarding the structure of the kidney*. Ruysch, by throwing his injections into the renal arteries, found that he filled the urinary tubes, the ducts of Bellini, and the pelvis itself. Hence he conjectured that the tubuli uriniferi or excretory ducts of the kidney were the continued branches of the renal artery, without the intervention of any glandular apparatus†.

* Ruyſch and Vieuſſens long contended for the claim of the diſcovery of the continuation of the arteries of the kidney into the urinary ducts. Ruyſch at firſt acquieſced in the opinion of Malpighi, as we have ſaid.

† Thes. Anat. ii. p. 31.

Example of Ruysch's doctrine*.

Ruysch's Plate.



Ruysch did not neglect the examination of the little bodies which are to be seen in the cortical substance. He did not however allow they were glands, but confidently asserted that they were merely the convoluted arteries which were formed into these contorted bundles before finally stretching out, and terminating in the straight urinary tubes†.

* Exhibet renis humani dimidiam partem ita diſſectam, ut reptatus vaſorum, preſertim ſanguineorum, luculentus quam in precedenti Theſauro, tab. iv. fig. iii. videre poſſit; ubi magis inherebam, ut conjunctiones arteriolarum cum ductibus Bellini exhiberem, in hac autem figura diſtinctiſſime vaſorum ſanguineorum curſum vermicularem per interiorem renis partem exprimere volui.

A. Facies renis exterior per quam vaſa ſanguinea reptatum obſervant vermicularem.

B. Facies renis interior ubi vaſa ſanguinea non minus curſum vermicularem obſervant quam in facie exteriore.

C. Papillæ renales.

D. Pelvis renis.

E. Cavitas pelvis in quam papillæ urinam ſtillando exprimunt.——See Theſaur. Anat. W. p. 27.

† In hoc Theſauro X. quoque inveniuntur objecta renalia ex homine deſumpta, in quibus non ſolum luculenter apparet quid judicandum ſit de prætenſis glandulis renalibus, verum etiam quid inveſtigatoribus renum impoſuerit, ſe in renibus indagandis ſæpiſſime occurrunt corpoſcula rotunda glandulas mentientia quæ revera nil ſunt niſi arteriolarum ultimæ extremitates contortæ; cum autem exactiſſime repleantur arteriæ renales diſſolventur vel expanduntur, quemadmodum fili glo-

When after minute injection of the kidney we make a section of its whole substance, we see vessels emerging from the more confused intricate vascularity of the cortical part, and running inward in striæ towards the papillæ; what we see there, are, in my conception, chiefly veins. And this I conclude, both from the result of injections, and from knowing that the veins are in general numerous surrounding the excretory ducts; besides they retain the blood in them like the veins. These vessels running in straight lines and converging towards the papillæ are not the tubuli uriniferi, but the blood vessels accompanying them, the tubes themselves being transparent.

Yet I imagine it was by these vessels that Ruysch was deceived; for tracing them from the extreme arteries, and seeing them suddenly altered in their form and direction, and running towards the Papillæ, he imagined them to be the excretory ducts continued from the extreme branches of the arteries.

Winslow supposes the corpuscules, which are seen in the cortical part of the kidney, to be the extremities of the cut tubuli, filled either with blood or with a coloured injection. But this they evidently are not; for by making the substance around them transparent, they are seen within the surface, and they are little grains not the extremity of tubes, nor extended in lines.

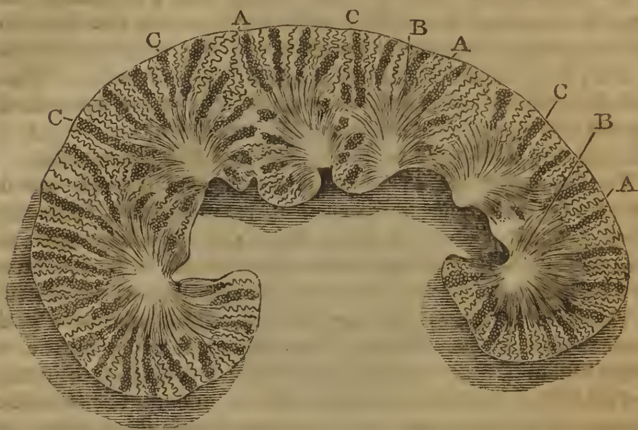
Boerhaave, although he saw in the preparations of Ruysch the injection passed into the uriniferous tubes, yet in the main favoured the opinions of Malpighi; and having sometimes observed these tubes filled with injections, while at intervals they were transparent or pale, and contained only a watery fluid, he ventured to conclude that there was a double operation going forward in the kidney; that the pale watery urine was quickly drawn off by the continuous tubes; but that the urine of the other quality and higher colour was separated by a more perfect and slower secretion through the glandular bodies.

In the history of opinions, to Boerhaave succeeds Bertin, who writes a long and laboured paper in the Memoirs of the Academy of Sciences for 1744; upon the whole, he may be considered as endeavouring to prove by dissection what was rather an hypothesis with Boerhaave. Bertin describes glands

mer, ita ut nil minus ſint, ſicuti dixi. quam partes per ſe ſubſiſtentes, & peculiari membranula obductæ ſine quo immerito dicuntur glandulæ. Interim conſiderandum ejuſmodi contorſiones vaſorum ſang. nuſquam in cæteris viſceribus reperiri. In the epiſt. to Boerhaave, p. 77, we find Ruyſch ſpeaking much more modeſtly: "In rene humano rotunda corpuſcula eſſe, fateor, ſed ſunt tam exilia, ut nihil poſſim definire de illis. Adeoque non licet magis dicere quod ſint glandulæ, quam aliud quid."

in the substance of the kidney; but these he is careful to distinguish from the corpuscules of Malpighi, which he also conceives to be the extremities of vessels merely.

M. Bertin's Plate.



From this plate we shall easily understand Bertin's description. He observes, in the first place, that there are to be seen serpentine vessels, such as Ruysch described: for example, at A A A*, which arising at the circumference of the cortical substance, are reflected inward in a tortuous form, and which, at last, approaching the tubular part, terminate in straight tubes, or are continued into the tubuli uriniferi (for example at B B).

But betwixt the mesches of vessels which are described, and which are seen here to terminate in the tubuli, there are beds of glands C C C, which acervulæ of small glandular bodies are as it were laid in the tract from the circumference towards the centre, and appear to terminate, or to be connected with the tubuli uriniferi as the arteries are.

M. Ferrein has opposed all these opinions in a paper of the Academy of Sciences for 1749. He asserts that the body of the kidney is neither composed of glands nor a congeries of blood vessels; that it is a peculiar substance, which when examined is found to consist of transparent vessels. These, he says, are wonderfully convoluted in the cortical part of the

* Mesches de M. Winslow on vesseaux spongieux de Vieussens ou tuyaux serpentans de Ruysch.

kidney, so as to resemble glands, and stretch in parallel lines towards the papillæ, where they form what is called the tubuli uriniferi. Amongst these transparent tubes, the blood vessels ramify to great minuteness, and accompany them where they are reflected directly inward to form the tubuli. Much ridicule, he observes, has been thrown upon the term parenchyma of the ancients; but notwithstanding he affirms that there is in all glands a substance dissimilar from the blood vessels, a gelatinous-like matter, which consists of or contains these pellucid tubuli.

Tubular Part.—The term here used is universally received; and all seem agreed that the striæ converging to the centre of the kidney, and taking a pyramidal shape are the excretory ducts. We have seen that they were supposed by some anatomists to be formed by the continuation of the extreme branches of the arteries; but this opinion we shall venture to say arose from the appearance of the blood vessels injected, which lie parallel and close to them. They are evidently transparent tubes, and probably the fibrous appearance of the whole pyramidal body formed by them is owing to the accompanying blood vessels. These lesser ducts, as they approach the papillæ, terminate in larger ducts, which finally open into the ducts of Bellini at the point of the papillæ. The papillæ we have seen to be that part of the pyramidal body which projects into the calyx or infundibulum, and from their point little drops may be perceived to run (from the ducts of Bellini) when they are compressed.

I have detailed the several opinions regarding the structure of the kidney; and neither do I wish here to vamp up an opinion from the aggregate of these contradictory reports, nor have I been able to draw a decided conclusion from my own experience. In truth, the observation from one dissection I have hitherto found so completely contradicted by other experiments, that I must conclude there yet remains much to be done in investigating the minute structure of the glandular viscera.

OF THE CAPSULÆ RENALES*.

The renal capsules are glandular-like bodies one attached to each kidney. The capsule is seated like a cap on the upper end of the kidney. It is of a form like an irregular crescent, and suited to the shape of that part of the kidney to which it is attached; at the same time that it has three acute edges, or

* *Glandulæ atrabilariæ renes succenturiatæ. Glandulæ renales*, &c.

takes a triangular form.—(See the drawing of the kidnies of the fœtus.)—The upper edge has been called crista, while the lower edges have the name of lobes. It is in the fœtus that the renal capsule is large and perfect; in the adult it has shrunk, and no longer bears the same relative size to the kidney. In the fœtus the renal capsule is as large as the kidney, and the capsules of each side are continued into each other, being stretched across the aorta and vena cava.

The vessels sent to this body are somewhat irregular; they come from the renal or emulgent arteries and veins, from the cæliac artery or phrenic, or from the trunk of the aorta, and even from the lumbar arteries.

By separating the lobes of this body we find something like a cavity, which has been roundly asserted by some to be a regular ventricle; by others altogether denied. Finding a cavity, they supposed they must discover the excretory duct. Some conceived that it must be connected with the pelvis of the kidney; some with the thoracic duct; some with the testicle; but every thing relating to the use of this body has hitherto eluded research, and all is doubt and uncertain speculation. For my own part I rather conceive that this body is useful in the fœtus, by deriving the blood from the kidney, that gland not having its proper office, of secreting the urine, to perform in the fœtus.

PART THE SECOND.

OF THE MALE PARTS OF GENERATION.

AS there is no very accurate division betwixt the viscera of the abdomen and those of the pelvis; as the viscera of the pelvis, when distended, rise into the belly, and are in every respect like the abdominal viscera, many have objected to a division of the viscera of the abdomen and pelvis: nevertheless, there appears to be good reason for this division of the subject. The function of the parts is different; the manner of their connection is different; their diseases have widely different effects.

We have seen that the pelvis consists of the sacrum and ossa innominata, and that anatomists have distinguished the true and the false pelvis. The false pelvis is formed of the extended wings of the ossa ilii, and supports the viscera of the abdomen. The true pelvis, marked by the cavity sinking beneath the promontory of the sacrum and the linea innominata, contains the rectum; the urinary bladder; the prostate gland; the vesiculæ seminales; and part of the urethra.

The manner in which these parts are connected, and the anatomy of the urinary bladder, prostate gland, and urethra, will form the subject of the first section; while the anatomy of the parts connected with those of the pelvis in function, but seated without, will form the subject of the second.

CHAP. I.

OF THE PARTS WITHIN THE PELVIS.

WE have seen that the abdominal viscera are involved in a common membrane; that this membrane is uniformly smooth; and that it has a secretion on its surface which bedews the whole, and allows the parts an easy shifting motion on each other. The parts in the pelvis must also have motion, but they are at the same time more strictly connected; a loose cellular membrane is the medium of adhesion here: the parts are imbedded in cellular membrane, which is interwoven with muscular fibres towards the lower opening of the pelvis, and further braced by the levator ani muscle. This gives to the whole due support; enabling them to resist the compression and action of the abdominal muscles, which they must receive in common with the higher viscera of the belly.

By turning to the first plan in this volume we find, that the division of the parts in the pelvis and abdomen is not well defined; but we see that the peritoneum is reflected from the pubes over the urinary bladder, and mounts again upon the rectum. The line of division, therefore, is the peritoneum; while we understand how the bladder which belongs to the pelvis, being distended, carries the peritoneum before it, and rises into the abdomen.

SECTION I.

OF THE BLADDER OF URINE.

As the general nature of the urinary bladder is so well known, nothing is more superfluous than a general definition or description. It is attached behind the os pubis; is nearly of a regular oval, when moderately distended, with the ends obtuse; but from its connections, and the pressure of the surrounding parts, this regular extension is not allowed in the living body; it stretches more laterally; its fore part is attached broad to the back part of the os pubis; and, behind, it is opposed by the rectum. What the name would imply to be the lower part, is above; for the *fundus* of the bladder is that part which, when distended, rises into the belly; the neck is where it terminates in the urethra behind the arch of the os

pubis. When the bladder is empty, or contains only a moderate quantity of urine, it takes a triangular figure, the base of which rests on the rectum, and the apex is attached to the back of the os pubis; and when in dissection you look down into the pelvis, you find the back part of the bladder flat, and as it were stretched obliquely up upon the os pubis.*

STRUCTURE OF THE BLADDER.—Like the other hollow viscera, the bladder consists of several coats.

THE PERITONEAL COAT of the bladder does not surround the bladder, but only covers the fundus and back part. It is like in every respect to the peritoneal coat of the abdominal viscera; smooth without; and adhering to the inner coat by cellular membrane; which cellular membrane is, however, of a looser texture, and in greater quantity than in the abdominal viscera. This peritoneal coat is no doubt of much service as a division in obstructing the course of inflammation arising from the diseases in the lower part of the pelvis, or from operations performed on the bladder, rectum, or perinæum: were it not for the loose peritoneum spreading over the cellular texture of the pelvis, we could neither be so bold or so successful in our operations here. That portion of the peritoneum which covers the back part of the bladder, forms a particular transverse fold when the bladder is contracted. This fold surrounds the posterior half of the bladder, and its two extremities are stretched towards the side of the pelvis, so as to form a kind of lateral ligament.

Though in the contracted or moderately distended state of the bladder, the peritoneum stretches from the back of the os pubis to the bladder, the distension of the bladder, in an immoderate degree, raises the peritoneum off from the pubes, so that the bladder can be struck with a trochar, or lithotomy performed above the pubes, by an incision directly into the bladder, without piercing the outer or peritoneal coat.

Towards the lower part, the bladder, as we have seen, is invested only by cellular membrane, which takes the place of the peritoneal coat of the fundus. While we are aware of the effect of the peritoneum, stretched over the parts in the pelvis, in obstructing the progress of inflammation from the bottom of the pelvis towards the abdominal viscera, we must recollect that there exists such a sympathy betwixt the bladder, and the stomach and bowels, that both after operation, and in consequence of obstruction of urine, the patient will sink, in conse-

* This flatneſs of the bladder, and the nearneſs of the back part of it to the os pubis, the ſurgeon would do well to remember, before he thruſts the gorget or ſtilet with ſuch relentleſs impetuoſity as I have ſeen done.

quence of abdominal inflammation, without the direct spreading of the inflammatory action.

Muscular coat.—The muscular coat of the bladder is very strong. Three strata of fibres are described by authors. They are so strong as to have been classed with the distinct muscles, and the whole coat has been called DETRUSOR URINÆ. Towards the lower part of the bladder the fibres are particularly strong, and formed into fasciculi, and are like a net of muscles inclosing the bladder.

Towards the neck of the bladder the circular fibres are strengthened; and embrace the beginning of the urethra; and form a sphincter, which, no doubt, is assisted in its operation by the levator ani muscle, throwing its strong fibres around the neck of the bladder. The muscular coat of the bladder becomes greatly stronger, where difficulties oppose its discharge; and when there is a source of irritation, within the bladder, acting for any time, the whole coats become thickened, sometimes to the depth of half an inch or more; in which case, as we have observed, to take place in the stomach, it is capable but of a very inconsiderable change, either by detention or contraction; consequently the urine runs frequently by painful discharges. The lithotomist would do well to distinguish when this symptom is merely the consequence of a stone in the bladder, and when it is owing to an increase in thickness, and a rigidity of the coats of the bladder; for, in the latter case, the operation of the gorget is attended with very serious evils.

We have an idea of the wonderful degree of contraction in the bladder, and indeed the extent of motion in the muscular fibre in general, when we consider that the bladder extends so as to contain two pounds of urine, and contracts so as to force out the last drop from its cavity. When, however, the fibres are stretched too far, they lose the power of contraction, and often the young surgeon is deceived by what he conceives to be an incontinence of urine while it is really an obstruction.

VASCULAR COAT, OR CELLULAR COAT.

When I call this third coat of the bladder the vascular coat, it is merely from its analogy to that coat of the intestines which I have distinguished by the name of vascular. Anatomists have called it the nervous and cellular coat; the first of which is quite improper and the last apt to be confounded with the surrounding cellular outer coat. This coat (if coat it may be called) consists of very extensile white lamellæ of cellular

membrane. It gives distribution to a few vessels, and connects the muscular fibres and inner coat.

THE INTERNAL COAT of the bladder is very smooth on its general surface, and is bedewed with a sheathing mucus. When the bladder is distended, no inequalities are to be observed; but when contracted it falls into folds and rugæ. From an acrid state of the urine; from strangury, from calculus, the mucous discharge is increased, even so as to form a great proportion of the fluid evacuated from the bladder. No visible source of this mucus is to be observed on the inner surface of this membrane*; so that probably it is a general discharge from the surface. Indeed, it appears, that no folicules or criptæ, discharging at particular points of the surface, could have the effect of bedewing and defending the whole surface from the acrimony of the urine. The great sources of the mucus discharged with the urine are, the neck of the bladder, the prostate gland, and the urethra†.

THE URETERS, which convey the urine from the kidnies to the bladder of urine, open very obliquely into the bladder, towards the back and lowest part of it. The consequence of their oblique perforation of the coats is, that, the greater the tendency of the urine to pass retrograde into them from the bladder, (there being a proportioned distention of the coats of the bladder,) the more their mouths are compressed. Thus, in the dead body, there is no degree of distention which causes the water to pass by the ureters. The contraction, or rather the resistance to distention, of the ureters and pelvis of the kidnies seems much greater than the powers of the bladder are able to oppose; for in obstructions of urine in the urethra, there is still an incessant accumulation in the bladder, even when the bladder has increased to such a size as to be compressed by the action of the abdominal muscles. The cause of this yielding of the bladder to the secretion of the kidney is, that it has little permanent contraction, though occasionally its action is very great.

The URACHUS does not belong to the human bladder. It is a tube which, in the fœtus of quadrupeds, communicates betwixt the bladder of urine, and the membrane called alantoes. But in the human fœtus there is no such communication; both in the fœtus, and somewhat less distinctly in the adult, there is a ligament like the remains of the duct which runs up between

* Winflow, however, defcribes the glands, and Heifter and Haller defcribe folicules, near the neck of the bladder, and round the infertion of the ureters.

† When the mucous fecretion is diminifhed by a difeafe of the furface, it feems much more readily to allow the calculous concretion to form upon it.

the peritoneum and linea alba of the abdomen towards the umbilicus*.

SECTION II.

OF THE PROSTATE GLAND.

On the neck of the bladder, and surrounding about half an inch of the beginning of the urethra, there is a gland nearly of the size and figure of a chesnut. This body is called the prostate gland. In all the extent of anatomy, there is not a more important subject for the attention of the surgeon than this of the size, relation and connection, and diseases (with their effects) of the prostate gland: but to enter upon these is not now our object.

The shape of this body is round, but at the same time somewhat pyramidal, for it is broad towards the bladder, and points forward. It has also a division, forming it into two lobes; and the older anatomists speak of it as double. The urethra passes through it; not in the middle, but towards its upper surface; so that the gland is felt more prominent downward, and is distinctly felt by the point of the finger *in ano*. This gland indeed rests, as it were, on the rectum. By the annexed drawing†, it is meant only to give an accurate conception of these parts, and not to represent them as they are felt in the living body. For this reason the drawing is made from a preparation, and not from the recent dissection. When the catheter is introduced, and the surgeon examines the state of parts by the rectum, he will first distinguish the curve of the staff, covered with the bulb of the urethra: behind this the catheter will feel more bare of parts, but still covered with a greater thickness of parts than one should expect from the description of the membraneous part of the urethra. And behind this, again, he will feel the prominence of the prostate gland, not round, distinct and accurately defined, but gradually lost in both before and behind, among the surrounding cellular membrane and muscular fibres which involve it.

The texture of the gland is a compact spongy substance, and when cut has considerable resemblance to a schirrous

* It has occurred, that the urine has been in part discharged by the umbilicus. This, no doubt, is owing to the ligament remaining permanently as a duct.

† Plates III. and IV.

gland. From each lobe there are small folicules opening into the urethra, and from these the ducts may be injected.

It has been said, that there is really no division of this gland into lobes: but perhaps the best authority on this question is disease. Now it happens sometimes that only one side of the gland is enlarged, which is a proof that there is some division betwixt the lobes. This unequal swelling of the gland distorts the urethra, and gives it a direction very difficult to be followed by the catheter. In general, when equally swelled, the greater part of the gland, being beneath the urethra, raises it up so that the point of the catheter must be raised over the enlarged gland before we can pass it into the bladder. This body is little liable to inflammation, and occasional tumefaction, so as to obstruct the urine; its enlargement is a chronic state, and peculiar to advanced age.

CHAP. II.

OF THE PARTS CONNECTED WITH THE VISCERA OF THE PELVIS, BUT SEATED WITHOUT IT.—OF THE PENIS AND URETHRA.—OF THE TESTES.

SECTION I.

OF THE PENIS AND URETHRA.

STRUCTURE OF THE PENIS.

THE penis consists of three spongy bodies; which, being constituted to receive the influx of blood, admit of distention, and consequent erection. Two of these bodies are called the CORPORA CAVERNOSA PENIS, and form the body of the penis; the other is the CORPUS SPONGIOSUM URETHRÆ, a vesicular and spongy substance, which surrounds the whole length of the

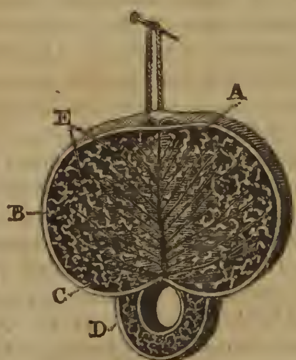
urethra, and expands into the bulb of the urethra in the perineum, and into the glans on the point of the penis.

Corpora cavernosa. The body of the penis consists of two tubes formed of a very strong sheath. This sheath has a great degree of elasticity, but at its utmost extension powerfully resists the farther distention with blood. These tubes are united in the greater part of the length of the penis, or they are parted by an imperfect partition. The root of these bodies, or crura penis, as they are called, separate in the perineum, so as to take hold on the ramus of the os pubis. Foreward, these bodies or tubes terminate in rounded points under the glans penis.

These tubes are of a ligamentary nature, bating that they have a certain degree of elasticity. They inclose and support the cavernous structure of the penis. This substance consists of cells connected with each other and having a free communication through the whole extent of the penis. These cells are interposed betwixt the extremities of the arteries and veins, or probably while the arteries have communication, and open into the extremities of the veins, in the common way, they have such connections with the cellular structure, that in the accelerated action they pour their blood into the cells ; yet the blood circulates in the penis during erection as at other times.

Section of the Penis as inflated.

Section of the Penis.



A, Corpus Cavernosum Penis. B, Septum. C, Urethra. D, Corpus Spong. Minus, or spongiosum Urethræ.

CORPUS SPONGIOSUM URETHRÆ.

Surrounding the urethra there is a spongy body similar to that which forms the body of the penis. Where this spongy sheath of the urethra lies in the perineum, betwixt the crura of the penis, it is enlarged with a round head, which is called the bulbous part;—it is upon this, and on about an inch and an half of the lower part of the spongy body, that the ejaculator seminis, or accelerator urinæ acts; and, as within this enlargement of the spongy body which surrounds the urethra there is also a dilatation of the tube of the urethra itself, the use of the muscle is evident. It contracts upon this sinus of the urethra when distended with the discharge from the vesiculæ, the prostate gland, and testicle. As an accelerator urinæ, it cannot act, but it expels the last drop of urine, as a consequence of their detention in this more dilateable part of the urethra.

The spongy sheath of the urethra, as we have hinted, is enlarged into the GLANS, so that the action of the accelerator muscle affects the whole length of the spongy body of the urethra and the glans by the compression of the blood in the bulb.

There is a connection betwixt the glans, spongy tube of the urethra, and accelerator muscle. The excitement of the glans gives the action to the accelerator or ejaculator muscle; the action of this muscle compresses the bulb, and in consequence the whole spongy body to the extremity of the glans is made tense, elongates, and contracts the diameter of the urethra, adapting it to the emission of semen. Mr. Home, I observe, supposes "that an action takes place in the membrane of the urethra during copulation, to reduce the size of the canal, and fit it for throwing out the semen with the necessary velocity:" but for this, there seems no ground nor proof; and I imagine, the action of the accelerator, and the state of distention of the spongy body, will be a good substitute to his conjecture.

The obtuse point of the glans is spread upon the extremities of the cavernous bodies of the penis, which yet have no communication with the glans. We observe a circular margin, the corona glandis, and behind this the cervix. About the corona and cervix there are many little glandular folicules*, which are no doubt for preserving the mobility of the preputium.

THE PREPUTIUM is a loose prolongation of the integuments of the penis, which hangs over and defends the delicate and sensible surface of the glans. Its inner surface is of course

* Glandul. odorif. of Tyson. See Morgagni.

the continued surface of the common integuments, while it again is reflected over the glans. Upon the lower side the preputium is tied in a particular manner to the surface of the glans behind the orifice of the urethra. This connection limits the motion of the preputium, and is called FRENUM PREPUTII.

The whole integuments of the penis are of the same cellular structure with those of the rest of the body, and may be with equal facility inflated: they are particularly loose and distensible, and unincumbered with fat.

A third common integument of the penis is distinguished, and is called the tunica nervosa. It is of a more firm elastic ligamentary substance. A ligament, however, is not elastic, and the firmness here is merely that of a greater degree of condensation in the common membrane. It is this membrane, which being attached to the os pubis, and supporting the penis, forms the ligamentum elasticum suspensorium.

A Glans.
B B Corona Glandis.
C Cervix.
D Corpus Cavernofum Penis.
E E Corpus Spongeofum Urethræ.
F Crura of the Penis, by which it is attached to the Ramus of the Pubis.
H Vena ipfius Penis.

OF THE URETHRA.

The urethra is all that length of the canal from the neck of the bladder to the extremity of the penis. It is formed of the continuation of the inner and third coat of the bladder, which last forms a reticular membrane, uniting the inner membrane to the spongy body. It is, however, supported through all its length, near the bladder, by passing through the prostate gland and sphincter fibres; further forward than this, where it passes from the prostate to the beginning of the spongy body of the urethra, it is invested and supported by firm cellular and ligamentous membranes; and in the length of the penis it is included in the spongy body, which extends from the bulb to the glans. It cannot be described as a cylindrical canal, for it admits of very unequal distention. It begins large at the neck of the bladder, where, immersed in the prostate gland, it forms a little sinus; it is contracted again in a remarkable degree behind the bulb; it dilates into the SINUS OF THE URETHRA within the bulbous enlargement of the spongy body; it is gradually diminished forward; and it may be considered as cylindrical forward to the point of the glans, where it is much contracted*, and where we often find calculi detained, which have passed the whole length of the canal.

The canal of the urethra is bedewed with mucus. The sources of this mucus are here particularly apparent; for, besides the general surface, there are large lacunæ seen; into which the mucus is secreted, and from which, as from receptacles, it is pressed as the urine flows. The inner membrane of the urethra is very delicate, and, when torn by the catheter, or by violent chordee, or opened by the caustic, bleeds profusely.

The internal membranes of the bladder and urethra are particularly sensible; drawing after them, when excited, not only the action of all the muscles in the lower part of the pelvis, but having sympathies in a particular manner with the testicle, stomach, and bowels, and with the whole system. The more curious and important effect of the injury of the urethra is the paroxysm of fever which it induces. Observing the regular occurrence of an intermitting fever in cases of fistula in the perineum, we should imagine it to be the effect of the extravasation of the urine in the cellular membrane, and the effect of general irritation; until it is observed that the simple

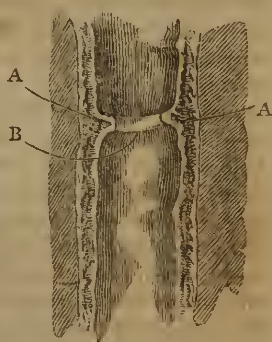
* Haller Com. lib. xxvii. sect. i. § xxx. Mr. Home's Strictures.

stricture produces that effect, and that a touch of the caustic brings on a violent paroxysm.

When the reticular membrane is inflamed, of course it loses its elasticity, and gives pain in erection. Sometimes the inflammation, being continued to the spongy body surrounding the urethra, makes it unequal in its capacity of distention to the cavernous bodies of the penis, and sometimes their cells are united by adhesion in the worst cases of chordee.

I cannot imagine with some, that the urethra is muscular; *first*, because I see no end it could serve in the œconomy; *secondly*, because there is no proof in support of the opinion; *thirdly*, because it is surrounded with strong fibres and a spongy body, which conjointly seem calculated for every purpose of the œconomy, and likely to account for every symptom which might be mistaken for spasmodic action in the canal itself. The idea of muscularity is derived from the symptoms of stricture and irritability of the canal. I shall therefore, in the first place, shew how I conceive stricture is produced.

The urethra is very elastic; not only allowing a very large bougie to be passed, and closing upon a thread, but it still more remarkably admits of elongation than of distention in the width of the canal. It is surrounded, as we have seen, with a spongy body and the cellular coat which is betwixt the delicate lining membrane of the urethra, and the spongy body partakes of the structure of both, and is very elastic. But when an inflammation attacks the canal, this cellular membrane is its principal seat. The point affected loses its elasticity; no longer stretches with the penis and urethra, but consolidates, and throws the inner membrane into a fold in a direction across the canal. Thus the membrane at A has contracted and condensed in consequence of inflammation, or rather, when contracted, by the shrinking of the urethra in length and its spongy body has formed an adhesion, and, in consequence of inflammation, has lost its elasticity and no longer dilates in the proportion of the rest of the canal. The consequence of this is, that the point of the inner membrane B makes a projecting ring round the urethra. To suppose this stricture to have been formed by



the muscular contraction in the diameter of the canal*, would be to allow the partial action of one or two fibres; (for the stricture is like that which would be produced by the tying of a pack-thread round the canal, being a narrow circular ridge;) which is very unlikely. Sometimes, however, the stricture is only on one side of the canal, which, allowing it to be formed as I have here supposed, is very likely to happen: but in consequence of the muscular action, cannot easily be supposed to take place, since the drawing of the muscular fibres would equally affect the whole circle.

As to the effect of heat and cold on an obstruction, it may be explained simply, without the supposition of muscular contraction: for as we know that the penis, spongy bodies, and of course the whole canal, relax and elongate in warmth, as they are shrunk up and contracted in cold, like the skin of the body in general, without implying muscular contraction: so we see how this state would affect a stricture;—that, when the penis and the urethra was shrunk, the effect of the stricture would be increased, and the patient could pass his urine only when the parts were relaxed, by sitting in a warm room, or by the use of the bath.

But when surgeons speak of spasms of the urethra, they seem to forget the action of the surrounding muscles. Thus acrid and stimulating urine, or an irritable state of the urethra, will be followed by a small stream of urine: or perhaps a temporary obstruction is the consequence: but why should we suppose that the membrane of the urethra, which has no appearance of muscularity, causes this effect, when it is probably produced by the sphincter muscle, the fibres which surround the membraneous part of the urethra, the levator ani, and, above all, by the accelerator urinæ, a muscular sheath of fibres surrounding three or four inches of the canal. Round the membraneous part of the urethra, and behind the bulb, there is much interlacing of muscular fibres; and the levator ani, splitting, embraces it. Round the sinus of the urethra and the bulb which covers it, is the accelerator urinæ, more properly the ejaculator seminis: and as the ejaculator seminis contracts upon the sinus, it drives onward the semen along the urethra, since the seminal fluids do not pass backward into the bladder, unless when the action of the parts is much disordered; there must be a contraction round the urethra behind the bulb during the action of the ejaculator. The sensibility of the glans

* "A ſtricture," ſays Mr. Home, "whether in the ſpaſmodic or permanent ſtate, is a contraction of the tranſverſe fibres of the membrane which forms the canal."

holds a controul over the action of these muscles; and the disease of the bladder and of these parts affects the glans. There is, in short, a complicated apparatus here, and we cannot wonder, that the most frequent seat of disease is just at the beginning of the sinus of the urethra, where the muscular action is stronger, and the canal narrowest. At this place is the stricture of the urethra most common, and here if spasm and muscular action should bring it on, if spasmodic action should prevail during the permanent stricture, or blistering bring on a strangury, (seeing that this point is so surrounded with muscular fibres destined to a particular action,) we must not take these symptoms as indicating a muscularity in the whole tract of the urethra. I believe it is found, that stricture is most frequent just behind the bulb of the urethra; where I have alleged, the muscularity is greatest; and also about the distance from the extremity of the urethra which answers to the termination of the ejaculator muscle.

SECTION II.

OF THE TESTES.

The testicle might be considered as more naturally connected with the abdominal viscera, than with those of the pelvis, as its original seat is on the loins amongst the abdominal viscera, and as it receives its coats from the peritoneum, and its vessels from the abdominal vessels.

The testes are two glandular bodies which secrete the semen: they receive their vessels from the aorta and cava, or the emulgent vessels; their excretory duct runs up into the belly, and it terminates in the urethra near the neck of the bladder.

The scrotum, in which the testicles are lodged, is a continuation of the common integuments; its cellular membrane is particularly lax and free from fat, and anasarca extremely apt to fall down into it, so as sometimes to distend the scrotum to a transparent bag of enormous size; and not unfrequently it has been blown up to counterfeit rupture and other diseases.

The cellular substance of the scrotum is peculiar in its appearance, being red and fibrous. It has been considered as a muscle, and called dartos: although this is denied by many. Its action is to support and brace the scrotum; and in bad health*, and in old age, it is so much relaxed as to allow the

* Nurses particularly attend to the state of the scrotum in children.

testicles to hang upon the chords. But besides the simple corrugation and relaxation, the scrotum has a motion like the vermicular motion of the intestines, from side to side, and alternately. Its contraction has a relation to the healthy secretion of the gland within.

Upon the surface of the scrotum, directly in the middle, there is a line passing from the lower part of the penis to the anus; the RAPHA. This line marks a division in the scrotum, not superficial merely; but a partition, or septum, is formed, dividing the scrotum into two distinct cellular beds for the testicles.

COATS OF THE TESTICLE. Besides the involving scrotum, each testicle has two distinct coats, the tunica vaginalis and tunica albuginea. The tunica vaginalis covers the testicle loosely; that is, without adhering to its general surface; but the albuginea is in close union with it, and is the immediate coat of the testicle. The inner surface of the vaginal coat is perfectly smooth, and an exudation is poured out from it, as from the peritoneum within the belly, the outer surface of the tunica albuginea is also smooth and firm, and white, whence its name. But on its inner surface, like the peritoneum, which covers the intestine, and adheres to the muscular coat, it adheres to the tubes of the testicle itself. These investing coats are in some respects dissimilar, yet in general much alike, being continuations of the same membrane, and both prolongations of the peritoneum. The outer membrane, the tunica vaginalis, is a protection to the testicle, gliding easily on the inner coat, and with the mobility of the cellular membrane of the dartos it preserves the testicles from bruises and strokes to which it would be exposed if it were more firmly attached. The inner tunic, or albuginea, gives strength and firmness to the substance of the testicle. Betwixt these coats is the fluid collected, which forms the hydrocele. They also contain the congenital hernia; but the common hernia is without both coats of the testicle. To understand the principles of anatomy of this part, we must attend to the descent of the testicle, and to the manner in which these coats are formed.

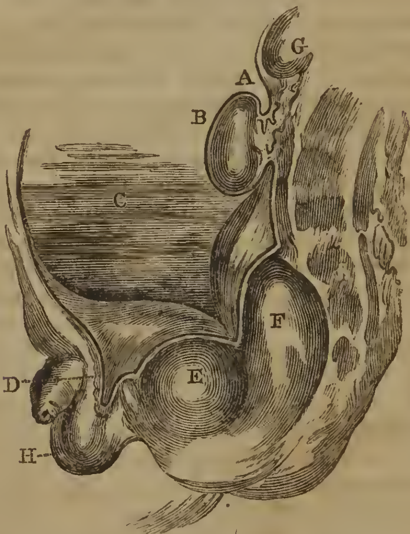
OF THE DESCENT OF THE TESTICLE.

In the fœtus, some months before birth, the testicles are lodged in the belly, and are in every respect like the abdominal viscera. They are seated on the fore part of the psoæ muscles, by the side of the rectum. They are of course covered and invested by the peritoneum; for, as we have explained how the solid viscera and the intestines are behind the peritoneum,

so it will be understood how the testicles lying on the loins are behind the peritoneum: that is to say, the glandular substance of the testicle is invested by a single coat, and that coat is the peritoneum, which, after covering the body of the testicle, is reflected upon the loins; as the coats of the liver, for example, are to be traced from its surface to the diaphragm: no words, however, can well explain this subject, and it will be better understood by sections and plans.

First Plan of the Testicle.

1st Plan of the Teſticle.



We see that the body of the testicle A is seated on the loins, that it is attached by vessels, and invested by the peritoneum. This surrounding of the body of the testicle by the peritoneum forms that coat which is in union with its substance, and which descends with it into the scrotum, and forms the tunica albuginea.

The figure and presenting surfaces of the testicle, while within the belly, are the same which we find after it has descended into the scrotum. It stands edge-ways forward, and the epididimis lies along the outside of the posterior edge of the testes. We see that it is attached, by the peritoneum being reflected off from its back part, and we can trace the peritoneum upwards over the kidney G, and downward over the rectum F, and bladder of urine E.

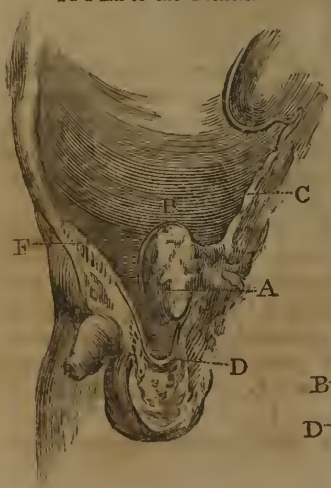
We may also observe a process of the peritoneum which has

passed through the abdominal ring, and which in this plan is marked D. Now it may easily be understood that the testicle A, gradually shifting its place from its connections in the loins, drops down into this sheath D. It will also be easily understood how the testicle covered with its first coat B, (viz. the tunica albuginea,) when it has fallen into D, is invested by this sac of the peritoneum, and that this last covering will come to be the tunica vaginalis. The tunica vaginalis is so called because it covers the testicle like a sheath ; that is, it does not universally adhere to the surface of the albuginea, as that coat does to the body of the testicle.

Understanding the nature of the peritoneum, we may learn the meaning of this looseness of the outer coat of the testicle. By turning to the introductory section of the abdominal muscles, we find, that the inside of the sac of the peritoneum is smooth, and forms no adhesion ; whilst the outer surface, being in contact with the substance of the several viscera, has a connection with them by a common cellular membrane. Now, as the inside of the peritoneum does not adhere, as the surface of the peritoneum, (which in this first plan is towards C,) is smooth, and has no tendency to unite with the surface of the viscera ; so neither has the surface of the peritoneum at D, the tendency to unite with the peritoneum (or the surface of the albuginea,) at B, when it descends to meet it: consequently the coat of the intestines may be represented in this second plan, thus.

Second Plan of the Testicle.

2d Plan of the Tefticle.



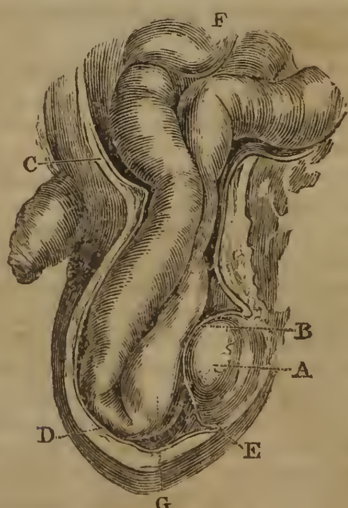
3d. Plan of the Tefticle.

In the first plan, we had the situation of the testicle in the fœtus represented. In the second plan, we have the middle stage of the descent represented: and, in the third, we have the full descent. In the second figure, A is the body of the testicle, B is the first peritoneal covering or tunica albuginea, which can be easily traced, reflected off from the loins at C; again, D is the portion of the peritoneum, which having descended before the testicle is presently, when the testicle has fully descended, to become the second, or vaginal coat of the testicle; F is the continuation of the peritoneum upon the inside of the abdominal muscles.

In the third figure of this series, we find the testicle A has descended into the scrotum; that it has one coat covering it, which we recognize to be the same with B, in the first figure, and that the peritoneum in this third plate at B, can be traced to C, the peritoneum within the belly.

Now supposing this to be the state of the testicle immediately after it has descended, we see that there is still a communication betwixt the cavity of the tunica vaginalis D, and the cavity of the peritoneum E. F is the kidney, covered by the peritoneum, and nearly in the situation in which the testicle was before its descent.

Fourth Plan of the Testicle.



From this fourth plan of the testicle, we may learn the nature of the congenital hernia. It is a hernia produced by

the intestine slipping down, from the communication betwixt the general cavity of the peritoneum, and the cavity of the tunica vaginalis, or in consequence of an adhesion betwixt the testicle and a portion of the gut, which of course causes the gut to follow the testicle, and prevents the communication betwixt the belly and the cavity of the tunica vaginalis from being shut. Thus, fig. 4. A, is the testicle, as it is seen in plan 3d. B, the tunica albuginea; C, the peritoneum within the belly; D, the tunica vaginalis, which we can trace from C, and which is distended and separated from the surface of the testicle, (i. e. of the albuginea) by a portion of the gut, which has descended through the ring: F, the intestines within the belly: G, the intestine which has fallen into the tunica vaginalis, and is in contact with the testicle; that is, in contact with the tunica vaginalis, which is in close union with the gland, and is considered as its surface.

We have explained the change which takes place in the situation of the testicle, as it relates to the peritoneum; but how this change is brought about, it is very difficult to understand. It is not a sudden pulling down of the testicle, but a very gradual process, continuing for months; it is not the effect of gravitation, for the fœtus may be in every variety of posture while in the womb, and generally the head presents. It is not respiration. Is it then the effect of the action of the cremaster muscle? or must we refer it to a law such as that which controuls and directs the growth of parts?

When the parts in a fœtus before the descent of the testicle are dissected, there is found a ligamentous, or cellular chord, mingled with the fibres of the cremaster muscle, and which takes its origin from the groin, is reflected into the abdominal ring, and stretches up to the body of the testicle. This body is called ligament or gubernaculum, and to the agency of this bundle of fibres, is the descent of the testicle attributed. There are, however, objections to this. If we suppose that the cremaster muscle, by its exertion, brings down the testicle to the ring, How does it pass the ring? for surely we cannot suppose that this muscle, which takes its origin from the internal oblique muscle, consequently within, can contract, not only so as to bring the testicle to the very point of its origin, but to protrude it past that point, and through the tendon of the external oblique muscle. Again, animals have the cremaster muscle, whose testicles never descend out of the belly;—again, the vessels of the chord, before the testicle has fully descended, show no marks of being dragged down, for they are elegantly tortuous.

As the testicle passes very slowly from the loins to the ring;

so, after it has escaped from the belly, it passes slowly from the ring to the bottom of the scrotum. It commonly remains some time by the side of the penis, and only by degrees descends to the bottom of the scrotum.*

In this change the testicles do not fall loose into the elongation of the peritoneum like a piece of gut or omentum in a rupture;—but, carrying the peritoneum with them, they continue to adhere to the parts behind them, as they did to the psoas muscle while in the loins: a point of importance to be recollected by the young surgeon.

The communication betwixt the belly and the sac of the vaginalis is very soon obliterated by the adhesion of the upper part, and then the whole extent of the passage (viz. from E. to D. in plan 3d of this series,) is shut. When this process is prevented in the first instance, when nature is baulked in the humour of doing her work, as Mr. Hunter observes, she can not so easily do it afterwards.

1 has also occurred that, this communication remaining after birth, a hydrocele has been produced by the distention of the tunica vaginalis, by fluids descending from the belly. The character of such a tumour will be, that the fluid will be easily forced into the belly. It may, however, be mistaken for a congenital hernia.†

It will already be understood, that in the common hernia of the groin or scrotum, the gut does not pass by the communication from the belly into the vaginal coat; that such communication no longer exists, and that when there is a rupture from preternatural wideness of the abdominal ring, or in consequence of a great violence, a new portion of the peritoneum descends with the gut before the chord of the testicle.

* Mr. Hunter has ſhewn, that the detention of the teſticle in the belly is in conſequence of ſome defect and want of action in the teſticle, and that thoſe who have the teſticle remaining in the belly have it imperfect or ſmall. This is contrary to an old authority:—The teſticles are ſeated externally, "for chaſtity's ſake, for ſuch live-wights as have their ſtones hid within their body, are very lecherous, do often couple, and get many young ones."

† Such is the remark of Mr. Hunter.

Fifth Plan of the Testicle.

Hernia.

This 5th plan will now illustrate the relation of the testicle to the herniary sac in the common scrotal hernia. A, the scrotum: B, the testicle; which will be easily understood to preserve its attachment to the back part of the scrotum: C, the tunica vaginalis, which here invests the testicle, but which is not now (in the adult or perfect state of the coats of the testicle), as is seen in plan 3d, open from D to E, but forms a short sac surrounding the tunica albuginea: D, the cellular membrane of the chord of vessels passing down to the testicle. And now there are no remains of the tube of communication betwixt the belly and vaginal cavity; it is obliterated and resolved into this cellular membrane.

We see then, that in this plan the testicle and its coats, and the spermatic chord, are in their natural situation, and that the herniary sac has descended before them. E, is the ring of the external oblique muscle of the abdomen, through which not only the testicle, with its coats and vessels, has descended, but also the hernia: F, the herniary sac, which contains a portion of the gut; it is formed of the peritoneum, fallen down from the belly, but it is quite distinct from the sac of the tunica vaginalis C. Whilst this new process of the abdominal peritone-

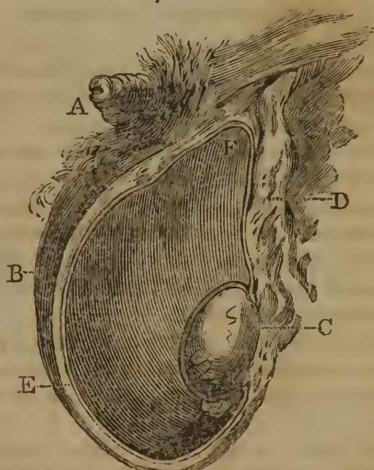
um has descended, it has contracted adhesions, and cannot now be replaced.

In thus explaining these important principles of anatomy, and which the anatomical student will find wonderfully to facilitate the more minute study of surgical anatomy, it only remains to show the nature of the hydrocele.

The hydrocele is a collection of water within the sac of the tunica vaginalis; that is, betwixt the tunica vaginalis and tunica albuginea. For, as we have seen, that the same surface of the vaginal coat is contiguous to the surface of the testicle (viz. the albuginea,) with that of the peritoneum, which is contiguous to the viscera of the belly; and as it has the same exudation, so it has the same disease, viz. a collection of water, from the absorption being disproportionate to the exudation. When the tunica vaginalis is distended with the water of a hydrocele, the testicle is towards the back part of the scrotum; it can be felt there; and when the scrotum is placed betwixt the candle and the eye, we see the transparent sac on the fore part of the tumour, the opaque mass of the testicle behind; generally the distended vaginal coat stretches up before the chord conically. Thus,

Sixth Plan of the Testicle.

Hydrocele.



A, the penis; it is generally corrugated thus, in consequence of the distention of the scrotum in scrotal hernia and hydro-

cele: B, the scrotum: C, the testicle, covered only by the tunica albuginea: D, the cellular membrane of the chord: E, the tunica vaginalis, distended with the water of the hydrocele, and consequently separated from the surface of the testicle: F, that part of the sac of the vaginal coat, which often extends conically before the cellular membrane of the chord D. Now we see that the distention of the vaginal coat does not open up the old communication with the belly; but that, the former communication being shut, and the peritoneum there degenerated into the cellular membrane of the chord, the hydrocele is a distinct sac, surrounding the testicle, and formed of the tunica vaginalis.

To understand this subject of the coats of the testicle, it is not necessary merely to consider the descent of the testicle; but the student must consider it in every point of view, turn it as it were into every variety of posture, without which his difficulties will perpetually return upon him. It is for this reason that I have endeavoured to represent simply the various states of the coats of the testicle in disease.

OF THE VESSELS OF THE CHORD AND TESTICLE.

In attending to the descent of the testicle, we have a cue also to the vascular system. If we did not know that the testicles were originally placed in the loins within the belly, we might wonder at the length and origin of the spermatic vessels.

THE SPERMATIC ARTERY rises from the fore part of the aorta, below the emulgent artery, or from the emulgent artery, (generally on the right side,) and sometimes from the arteries of the renal capsule: sometimes there is only one, sometimes there are two spermatic arteries. This artery, which the chord receives from the aorta or emulgent, is called the superior spermatic artery, because there is another which rises from the hypogastric artery: this branch runs upward, connected to the vas deferens, as it rises out of the pelvis.

These arteries, taking their course under the peritoneum, join the fasciculus forming the chord, and supply the chord, and send twigs to the investing peritoneum; they then pass through the abdominal ring, and in their course they are beautifully tortuous.

THE VEINS of the testicle rise on the right side from the trunk of the cava, a little below the emulgent vein, and from the emulgent vein on the left side. In the origin of these veins there are frequent varieties; there is also, accompanying the vas deferens, a vein, which joins the internal iliac vein. These

veins, in their course from the testicle, are protected from the column of blood, and from the bad consequences of compression, by numerous valves. These valves are very strong, and will bear a great column of mercury before they give way or burst. This plexus of convoluted veins of the chord is the most beautiful in the body. This convoluted state of the veins is ever attendant on great activity and exertion of the arteries of the part. If there is a provision in the shape, course, and strength of the arteries, for occasional acceleration of the blood through them; so will there be found in the veins a tortuous and varicose appearance; and again, if by accident there is excited an uncommon action in the arteries of a living body, that action will be apparent from the distended or enlarged state of the veins. In the testicles of such animals as have their seasons, the artery and veins of the testicle are still more convoluted, and form a mass of vessels, which has been called the corpus pyramidale.*

The nerves of the testicle, like the blood-vessels, come from the loins, and are continued down upon the vessels in the spermatic plexus. This still farther allies the testicle to the abdominal viscera, giving them much of the same sympathies. The stomach, intestines, and testicle, sympathise readily with each other. As we find the tunica albuginea of the testicle to be very firm, dense, and unelastic, the great pain in inflammation of the testicle has naturally been attributed to the resistance made by this coat to the swelling of the substance of the testicle, but much must be ascribed to the natural sensibility of the part, independently of swelling and tension; for in the very moment of a blow, a person faints and falls down from exquisite pain.

The lymphatics of the testicle are numerous, and easily demonstrated by blowing up the cellular structure of the body of the testicle; and we shall by-and-by find, that this has been the ground of dispute between physiologists; and the proofs of some important points in the doctrine of absorption have been drawn from the injection of the lymphatics of the testicle and chord.

The cremaster muscle, as we have seen in the first volume, takes its origin from the internal oblique muscle of the abdomen, and, passing down over the vessels of the chord, is ex-

* Corpus varicofum,—Corpus Pampiniforme; Galen de Semine. Alias paraftatam varicofam, Hall.—As the old phyfiologifts faw and obferved this wonderful tortuofity, and the tendril-like form of the fpermatic artery, they thought that as there muft be fomething peculiar in this ftructure, the blood was here begun to be changed into femen, and therefore they called them the vafa preparantia.

panded on the tunica vaginalis: its use is to suspend the testicle, and prevent it from dragging upon the vessels of the chord.

By constitutional weakness, or the relaxation induced by warm climates, this muscle becomes relaxed, and artificial suspension becomes necessary. Sometimes this muscle draws the testicle spasmodically to the groin; yet I cannot allow that this is the muscle which retracts and corrugates the scrotum, for the testicle will be thus drawn up by the cremaster, without corrugation or contraction of the scrotum. In some this would appear to be a voluntary muscle; it possibly accelerates the motion of the semen, or at least promotes its secretion.

Thus we find the chord of the testicle, as it is called, to consist of the arteries, veins, and nerves; of the lymphatics returning from the testicle; of the cellular tissue embracing and supporting all these vessels; and lastly, of the fibres of the cremaster muscle.

OF THE STRUCTURE OF THE TESTICLE.

It is to De Graaff that we owe the knowledge of the structure of the testicle; and indeed the merit of this great anatomist has not been acknowledged with sufficient gratitude by modern anatomists: but after the fervour of disputation has subsided, the merit of ingenuity and of discovery must return to him to whom it is due. No one more highly values than I do the improvements of anatomy by the Hunters and Monro: but I must say, that the structure of the testicle was demonstrated by De Graaff to his fellow anatomists of Montpelier, and his discoveries published in a manner so perfect, as to leave us little to learn from more modern authors.

De Graaff, by exciting animals to venery, and tying the spermatic chord, had the seminal vessels distended. He did not depend upon injections; by maceration and dissection in this distended state, he unravelled all the intricacies of their tubes. More modern anatomists have proved the truth of his observations by injections of mercury, and have succeeded in a variety of ways of preparing the testicle.

Tubuli testis.—When the tunica albuginea testis is lifted, the body of the testicle is found to consist of innumerable very delicate white tubes; which, when disentangled from the minute cellular membrane which connects them, and floated in water, exhibit a most astonishing extent of convoluted vessels. By a closer attention, however, to this structure before it is thrown into confusion by pulling out the tubes, they appear to be regularly laid in partitions of the cellular membrane. These sepimenta are very regular in some animals, and while

they separate the seminal tubes, they support and convey the blood-vessels to the secretion of the semen. Dr. Monro has denied the formal divisions which De Graaff has engraved, but acknowledges them less regular, less easily found, and not so limited in their number ; nor does he find them to prevent all communication betwixt the tubes of the testicle.

These seminiferous tubes of Haller, or tubuli testis of Monro, running in meshes, 15 or 20 in number, terminate on the back of the testicle. Each of these tubes seems to be cylindrical, or of one diameter throughout their whole extent: we see no communication betwixt them ; no branches given out or going into them ; no beginning for the whole, nor for any one of them. Though we cannot prove it, yet there seems to be only one tube wonderfully convoluted and folded up in each subdivision of the testicle.

Rete testis.—When the tubuli come out from the body of the testicle, they run along the back of it, and communicate by inosculations with each other, so as to form a net-work of vessels, from which appearance Haller named them rete testis.

Here it often happens that the mercury stops, when it has been injected backward from the vas deferens ; and it is this part which has been better described and drawn, in consequence of mercurial injections, than it was by De Graaff; for he, as we have said, saw this part only filled with semen.

Connected with the rete testis is the corpus highmorianum.—Where the lines of the membranous septa, and cellular membrane of the testicle, meet on the back of the testicle, and under the epidimis, they form a white line. This white line running along the testicle, was supposed by Highmore to be a hollow tube ; it was compared with the salivary duct ; it was thought to be a cavity leading from the body of the testicle to the head of the epididimis, and to form the communication by which the semen flowed from the testicle. De Graaff first refuted this notion, and shewed that it was not by this one great duct, but by these smaller tubes forming what has been now called the rete testis, that the semen came from the testicle : still it had continued a question, whether this white line was really solid, or a tube ; and upon faithful examination of the point it appears, that this is expressly as it was explained by De Graaff, viz. that it is a mere collection of the membranes of the body of the testicle, forming a linea alba ; and as the septa are more distinguishable in some animals, so is the corpus highmorianum*.

* This body called a mere *firmamentum* or binding, Winflow ; the nucleus teftis

VASA EFFERENTIA.—The tubes running on the back of the testicle, and forming the rete testis, we have understood to arise from the tubuli testis; now it is the continuation of the rete testis which is called vasa efferentia. The vasa efferentia are very delicate vessels which run out from the head of the testicle, single at first, but they are soon convoluted, and by these convolutions they are formed into an equal number of vascular cones, which constitute the head or larger part of the epididimis. These vasa efferentia and vascular cones are connected by a very delicate cellular membrane; and it is a piece of very nice dissection to display them after they are injected with mercury.

EPIDIDIMIS.—The vasa efferentia, after forming thin conical convolutions, unite and form larger tubes; these again uniting, form one large excretory duct, the *vas deferens:* but this vessel being convoluted to a wonderful degree, forms a body, which, being as it were, placed upon the testicle, has been called epididimis.

Seventh Plan of the Testicle.

7th Plan of the Teſticle.

In this representation of the dissected testicle, A is the body of the testicle divested of its coats; B, the tubuli testis*; CC, the rete testis; D, the vasa efferentia; E, the vascular cones; F, the epididimis formed of the convolutions of the vas deferens; lastly, G is the vas deferens.

In the substance of the testicle there are no glands nor

* Where the tubuli are emerging to form the rete vaſculoſum, they are called the *vaſa recta.*

folicules ; the arteries minutely ramify amongst the seminal tubes, and, there is reason to believe, secrete the semen into them. The seminal vessels in the substance of the testicle, or tubuli testis, run together upon the surface of the testicle, and form the rete testis. From the rete testis are continued the vascular cones : these convolute, and running together form the epididimis ; from which the tube is continued under the name of the vas deferens. It passes up the chord ; enters by the ring into the abdomen ; and then passing down into the pelvis, terminates in the vesiculæ seminales, in a manner presently to be explained. It is not likely that the vis a tergo, the power of the arteries, pushes the semen through all this length of tube, of which the epididimis itself is reckoned to be several feet in length, if the various convolutions were undone. Such an action on the testicle as that of the dartos or cremaster muscle, could give only a general stimulus, but could not force on the semen in tubes which take so great a variety of directions. We are therefore left to the supposition, that these tubes themselves have a power of accelerating the fluids through them.

Of the lymphatics of the testicle we shall afterwards treat ; it is, however, necessary here to remark, that Prochaska found in his injections a difficulty in making the mercury pass the rete testis into the testicle. Observing at the same time in his preparations, and in the drawings of all authors, an appearance of irregularities in this part like the valvular structure of lymphatics, he has been led to suppose that there is a provision here for preventing the semen from being forced backward into the testicle by the action of the cremaster muscle ; he conceives that when the cremaster muscle draws up the testicle to the groin, it may accelerate the semen in the epididimis, whilst this valvular structure prevents the regurgitation upon the delicate vessels of the substance of the testicle.

The annexed plate represents the appearance which I have found in my preparations. A, the vas deferens by which the mercury was injected ; B, the epididimis ; C, vessels running up the chord from the great head of the epididimis.

There is a duct which sometimes arises from the epididimis, and which has been found to terminate abruptly in a blind end—of this, Mr. Hunter speaks in the annexed note*.

* "By a fupernumerary vas deferens, I mean a fmall duct, which fometimes arifes from the epididimis, and paffes up the fpermatic chord along with the vas deferens, and commonly terminates in a blind end, near to which it is fometimes a little enlarged. I never found this duct go on to the urethra, but in fome inftances, have feen it accompany the vas deferens as far as the brim of the pelvis. There is no abfolute proof that it is a fupernumerary vas deferens ; but as we find

OF THE TESTICLE IN GENERAL.

The testicle is of an oval form, and of the size of a pigeon's egg: it is a little flattened on the sides: it hangs in the scrotum by the spermatic chord; one end of the oval, forward and high; see plan 8th B; while the other is backwards, and drops lower, C. The spermatic chord consists of the artery which brings blood; of the veins which return it; of the vas defferens, which carries the semen to the vesiculæ seminales at the neck of the bladder; of lymphatics, which are essential to the structure of every part. This chord of vessels comes down from the belly, and passes by the ring of the abdominal muscles; it is about four inches in length, and is fixed into the upper and fore part of the body of the testicle.

The body of the testicle is easily distinguished, and is the place where the secretion is performed. It is strictly the body of the gland, while the part above it is only the duct by which its fluid is discharged.

The ancients called the testicle dydimi, gemini, twins; they, therefore, called that part which is laid on the back of the testicle epididimis, as added to it. To the surgeon, it is essentially necessary to attend to the relation of the parts of the testicle as felt through the scrotum.

Eighth Plan of the Testicle.

8th Plan of the Tefticle.

the ducts of glands in general very fubject to fingularities, and that there are frequently fupernumerary ducts, there being often two ureters to one kidney, fometimes diftinct from beginning to end, at other times both arifing from one pelvis;

In this 8th plan, fig. 1. we see the testicle as in its natural situation, covered with its membranes, and appearing like one body; while, in the second figure, it being represented freed from its outer coat, we see the epididimis as laid upon the testicle, and consisting of the convoluted tube. First, we observe A, the body of the testicle; B, the beginning of the epididimis, or the large head of the epididimis*. Then we see it laid along the back of the testicle, and observe C to be the small head of the epididimis†, where the tube is reflected to reascend upon the testicle, and to form D, the vas deferens.

Now, we have to observe, that the point C, fig. 2. or small head of the epididimis, hangs over the testicle, and points backwards to the perineum, and can be felt through the whole coats; and that the body of the testicle A, is towards us when we examine a patient.—Further, as the letters in figure 1 and 2. refer to the same points, we have only to notice the fainter indication of the parts in fig. 1. it being invested with the coats; and to observe the general relation of the testicle to the scrotum and penis.

There is one other circumstance to be observed, viz. that the epididimis is always laid on the outer side of the insertion of the chord into the testicle; from which we distinguish, with ease, in a preparation, to which side the testicle belongs. Thus, in the annexed plans, the testicle of the left side is represented, which we know from the points c, being directed backward, while the epididimis is laid along the left side of the insertion of the chord.

OF THE VESICULÆ SEMINALES.

Behind the prostate gland, and attached to the lowest part of the urinary bladder, lie two soft bodies, which are the vesiculæ seminales. They appear like simple bags when seen from without, but dissections show them to consist of a cellular structure; each of these bodies is about three fingers-

these ducts, arising from the epididimis, I am inclined to believe from analogy, are of a nature similar to the double ureters. They resemble the vas deferens, as being continuations of some of the tubes of the epididimis, are convoluted where they come off from it, and afterwards become a straight canal passing along with it for some way, when they are commonly obliterated.

" The idea of their being for the purpose of returning the superfluous semen to the circulation is certainly erroneous, from their being so seldom met with, and so very seldom continued further than the brim of the pelvis."

* *Globus major*, or head.

† *Globus minor canda.* This part we often distinguish retaining its hardness after the subsiding of the general swelling of hernea femoralis. From this point we can trace all the connections of the other parts.

breadth in length; their backmost point is large and round, and, at the same time, that they diverge from each other, their narrow points unite, or are contiguous to each other forwards, and enter at the back part of the base of the prostate gland.

As we have seen, the peritoneum does not descend far enough betwixt the bladder and rectum to cover or invest these vesiculæ; they are therefore involved in the cellular texture, and covered with strong fibres, besides being subject to the compression of the levator ani muscle. When the vesiculæ are cut into, and especially when they are distended, dried, and cut, they present a cellular appearance; but if they are carefully dissected, they present the appearance of a small blind intestine convoluted.

This cellular appearance is given by the duplication of their inner membrane, together with the distortions and curves of the canal. Their outer surface is covered with a fine membrane, which, like a frenum, connects these cellular convolutions.

These are copiously supplied with arteries; their surface is covered with veins and lymphatics when these vessels are minutely injected, and their coat is thick and spongy. Heister, Winslow, and others, have described small glands as seated in their sinuosities; but these are confidently denied, and in their place there is described a pile or efflorescence. There can be little hesitation in affirming, that these vesiculæ are themselves glands, or, in other words, that the arteries secrete into them a peculiar fluid. The fore part of each of the vesiculæ, which we have said sink into the back part of the prostate gland, runs under the neck of the bladder, and opens by distinct mouths into the urethra, on the surface of the verumontanum.

The connection of the vas deferens with the vesiculæ, is very particular, it does not open directly into them, but opens with them into the urethra in such a way, that the semen from the testicle can pass into the vesiculæ, though its direct course is into the urethra*.

If air is blown into the vas deferens, the vesiculæ will be distended at the same time that the air passes into the urethra: the union of the extremities of the vas deferens and vesiculæ, forms a kind of septum betwixt them.

The extremity of the vas deferens joins the duct of the vesiculæ where it is imbeded in the prostate gland; the union of the vas deferens and duct of the vesiculæ is not attended with an enlargement of the duct; on the contrary, as the duct

* See explanation of plate III.

passes forward deep into the substance of the gland to arrive at the urethra, it becomes remarkably narrower until it opens in a very small orifice in the verumontanum, as we see represented in the third plate. The duct (if we may so call it,) of the vesiculæ passes a full inch forward into the gland before it terminates in the urethra.

These vesiculæ have been in general supposed to be receptacles for the semen; but as this is an opinion depending on the connection of these bags with the extremities of the vas deferens, and as comparative anatomy shows many instances of these vesiculæ being unconnected with the ducts of the testicle, there is much reason to doubt whether they really are merely reservoirs. They have always appeared to me as useful in adding a fluid to the secretion of the testicle, which being poured together into the sinus of the urethra, give a distention, exciting and giving effect to the contraction of the ejaculator seminis: For unless there were a provision of fluid sufficient to distend the sinus of the urethræ, the semen could not be thrown out from the urethra. This supposition is not opposed by the facts stated by Mr. Hunter, that in many animals the vesiculæ and vasa deferentia open by distinct foramina into the urethra, because in that case the fluids of these secreting bags might be equally mingled with the semen in the sinus of the urethra, although they do not flow from the same tube.

Verumontanum.—The verumontanum, or caput galinaginis, is an eminence on the lower part of the urethra, where it is surrounded by the prostate gland. As we observe in the drawing, it is larger and round towards the bladder, and stretches with a narrow neck forwards. On its summit, the two orifices of the seminal vessels open; and around it there are innumerable lesser foramina and mucous foliculcs.

PART THE THIRD.

OF THE FEMALE PARTS OF GENERATION.

THE ANATOMY OF THE PARTS IN THE FEMALE PELVIS.

THERE is considerable difficulty in presenting such a view of the anatomy of the parts of generation in woman, as may bear a due relation to this general system of anatomy, and, at the same time, be intelligible and complete. The subject is in itself extensive and important, sufficient to fill several volumes: it is much connected with practice; and the phænomena and diseases of the system serve greatly to illustrate the strict anatomy of the parts. I cannot here be allowed to give to it its due importance, whilst yet it is a subject not easily understood from a short abstract.

The parts of generation are divided into the external, which are those without the pelvis; and the internal, or viscera of the pelvis, and which lie within the bony circle of the pelvis.

CHAP. I.

THE EXTERNAL PARTS OF GENERATION.

THE external parts of generation are the mons veneris, labiæ, clitoris, nymphæ, urethra, hymen, or carunculæ myrtiformes. Upon these subjects we have no want of books and information; for accoucheurs of the old school dwelt upon the description with particular accuracy. These parts were within their ken, which we cannot say of the viscera of the pelvis: and, therefore, upon the former we shall be more brief.

In very young children these external parts bear a large proportion to the body, greater than at any subsequent period before the age of puberty. At puberty they are suddenly and completely evolved, and acquire an increase of size; while, from the age of two years to twelve or thirteen, there has been little increase. Immediately before menstruation, commences the connection which occasions, or accompanies that flux. It begins to effect the evolution of the uterine system, and to fit it for its peculiar function. The parts become turgid and vascular; the fat is deposited in the surrounding cellular membrane. About the fortieth year, when the menses disappear, this fullness of the private parts also ceases, and the fat is reabsorbed.

The MONS VENERIS is that prominence on the symphysis pubis, which consists of the skin raised and cushioned up by the fat inclosed in the cellular membrane. There is of course a great variety in its size. In early life it is small: it becomes, as we have said, more prominent at the age of puberty; in fat women it is of an enormous size; and in some warm climates a particular laxity prevails. From the hair on this part, marking the age of puberty, it is called pubis. As the lax texture admits of distention with the fluid of anasarca, it is sometimes from this cause very greatly swelled.

THE LABIÆ. These are often named alæ, from a slight resemblance to wings, and they are also called externæ, magnæ, or majores, from their place, and from their superiority in respect of size over the nymphæ. The labiæ seem to be the mons veneris continued downward, and laterally until meeting below, they form the vulva; at their lower angle, by their union, they form the fourchette, or frenum labiorum. The structure of the labiæ is similar to that of the mons veneris; sometimes one is larger than the other.

The great sensibility of the membrane which lines the inside of the labiæ, requires some defence, and therefore the whole surface is amply supplied with mucous folicules and glands. The labiæ are a protection to the other soft parts, so necessary, that the clitoris, or nymphæ, when they project beyond them, are subject to violent inflammation.

The parts here have either such folds, or are of so lax a texture, as to permit a great degree of distention during the passage of the child. But, as the labiæ have no muscular power, and depend entirely on their elasticity for restoring them to their original size, they commonly, after being very much dilated, remain in some degree larger and more lax. It is different with muscular parts, as the orificium externum, which, by the power of its sphincter, is restored after labour to its original size. In man, hernia descends from the abdominal ring into the scrotum; but, in woman, when there is a rupture from the ring, (which is rare) it may fall into the labiæ, though, I believe, it will be seldom found to descend thus far.

THE NYMPHÆ are named labiæ vel alæ minores, or labiæ internæ, to distinguish them from the great labiæ. They are like a miniature representation of the great labiæ; they are covered with a very delicate membrane, and have great sensibility. They begin immediately under the glans clitoridis, and seem to be only an extension of its preputium, formed by a folding of the membrane. Their size varies much. They commonly stretch downward, and backward to the middle of the orifice of the vagina; sometimes no further than to that of the orificium urethræ, and in a few instances they extend even the length of the fourchette*. They are very vascular, and have somewhat of a cellular structure, and thus partake of a degree of turgidity, in consequence of irritation and vascular action. The most modest of the uses ascribed to them is, that of directing the stream of urine. As they are obliterated during the passage of the child's head through the vulva, it is probable that they facilitate the necessary dilatation.

The nymphæ are, in their natural situation, covered and completely protected by the labiæ externæ. When naturally large or increased by disease, or in a very relaxed state, they are deprived of this covering: they project from under the labiæ, and are apt to become inflamed, and even to ulcerate. The original disease, or tumour, is augmented, or they become perhaps hard and callous. In children they bear a very great proportion to the other parts, and are more conspicuous

* Both Riolin and Morgagni have obferved the parts without the nymphæ.

and prominent than in the adult. Their diseased enlargement sometimes requires to be extirpated, in which operation, as they are very vascular, and as with their growth, their blood-vessels enlarge, considerable hæmorrhagy may be expected. A surgeon of this city, in extirpating a tumour of this kind from a young lady, thought his duty fulfilled when he had applied a piece of lint upon the surface after the operation, so that he even neglected to appoint an attendant. The hæmorrhagy returned, and continued so profuse that before the surgeon arrived the lady had fainted.

The clitoris is similar to the male penis. Like the penis, it consists of cells for receiving blood, and in a similar manner, it arises from, or takes hold of the rami of the os pubis by two crura ;—these unite at the symphysis pubis, to form the body of the clitoris, which is suspended from the os pubis, like the penis, by a kind of ligament. The clitoris has also a kind of glans, over which the integuments make a fold like a preputium. In short, it has the same sensibilities, the same power of erection with the membrum virile ; only it has no urethra nor spongy body, like that of the urethra of man.

The stories of the increase of this instrument, even to its pre-eminence in size over the male penis, are very idle, but there seems to be a peculiar predilection for them. It is not wonderful that a clitoris of such magnitude should suggest the idea of a hermaphrodite, or person partaking equally of the distinguishing attributes of either sex.

OF THE URETHRA.

The urethra of the female is short, straight, and wide ; its length an inch and a half, or two inches ; its direction nearly straight, or only slightly bending under the os pubis ; and its diameter such as will admit a catheter the size of a writing quill. The consequences of these peculiarities are, that the catheter is easily passed when there is no very unusual obstruction ; that women are not so much exposed to the disease of stone in the bladder as men, for though this is much owing to constitutional peculiarities, yet it is obvious, that when a small stone is formed, and passes from the bladder, it is easily discharged ; and, lastly, that lithotomy is a very simple operation in woman.

The opening of the urethra is in a direct line under, or behind the clitoris, and about an inch from it : It is in the middle of a slight prominence, and its vicinity is plentifully supplied with mucous glands. If the relation of the orifice to the clitoris be observed, there is, in the natural state of the parts,

no difficulty in sliping the point of the catheter, on the end of the middle finger, from the clitoris, until it is catched, upon the lacuna-like orifice of the urethra ; but even in this part of the operation, I have experienced great embarrassment, from an irregular ulcerated or cancerous surface of the parts, by which all the usual distinctions were lost.

From the length and sudden turns of the male urethra, from the double function it performs, and from its being embraced by the prostate gland, the obstructions of the urine are more frequent, and the catheter less easily passed, than in woman. The catheter too requires to be of a very peculiar form. The short and wide urethra of woman requires only a simple and almost straight tube : and although, accurately to adapt it to the course of the urethra, a considerable curve might be given to it, yet that is not necessary in common cases; and circumstances will occur to the accoucheur which will preclude the possibility of using such an instrument.

We shall only mention here such cases of obstruction of urine as are in a particular manner illustrated by the anatomy and connection of the parts. These are tumours of the ovarium, tumours of the womb, polypi, distension of the vagina, displacement of the womb, as procidentia, prolapsus, retroversio, &c. ; and lastly, the child's head in labour.

The ovarium being enlarged, and falling down into the pelvis, either presses upon the neck of the bladder, causing obstructions, or pressing and weighing on the fundus of the bladder, it occasions a stillicidium urinæ.

Tumours of the womb, especially of the neck or orifice, as it is in contact with the urethra, very soon affect this organ. Thus, I have seen a cancer of the orifice of the womb, by exciting inflammation in all the surrounding parts, and by massing them together into a tumor filling the pelvis, occasion obstinate obstruction of urine.

Polypi attached to the orifice of the womb, and filling the vagina, produce the same effect. In all such cases, perhaps, the tumour may be pushed up, so as to permit the flow of urine, or the introduction of the catheter.

A case occurred to Mr. John Bell, in which the tumour of the womb compressed the neck of the bladder. A catheter was passed, and gave instant relief. The midwife, after some time came, and said, that the catheter would not pass. He found that he could pass the catheter into the bladder, but no urine flowed ; and it was discovered, that the tumour increasing backward, came to press upon the ureters, so as completely to obstruct them where they enter the bladder. The

woman unavoidably died; each kidney and ureter was found to contain four or five ounces of urine.

A slight sketch of the parts in the female pelvis, will perhaps, better explain the connections of the neck of the bladder than any description, and will certainly better illustrate the cause of some kinds of obstruction, particularly that arising from the change in the posture of the womb.

First Plan of the Female Pelvis

A, the os pubis cut through.—B, the spine and sacrum also cut directly down.—C, the urinary bladder moderately distended, and rising behind the pubis.—D, the urethra, very short, and taking a gentle curve under the symphysis of the os pubis.—E, the fundus of the womb.—F, the os tincæ, or orifice of the womb.—G, the vagina.—H, the rectum.

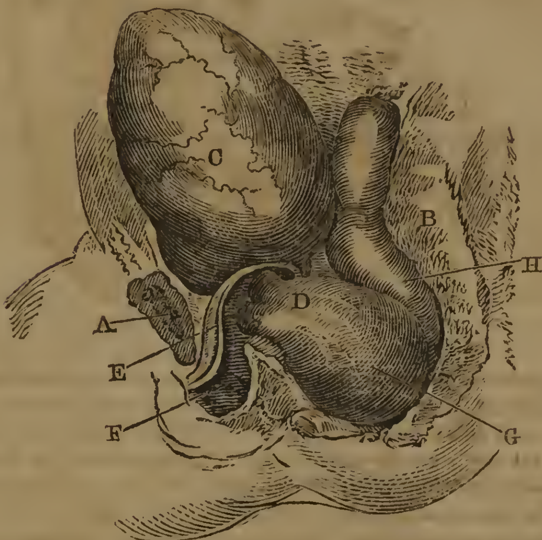
Prolapsus, or falling down of the womb, is frequent with those who have born many children. By this slipping down of the body of the womb F, into the vagina G, it presses on the neck of the bladder, or urethra. This is also apt to happen in the first months of pregnancy, from a degree of difficulty which the womb in its enlargement has in rising above the brim of the pelvis.

We may observe also from the place of the vagina G, that its diseases, its scirrhous hardening, its distention by the menses, will also compress the urethra and neck of the bladder.

The retroversion of the womb is the most formidable obstruction to the urethra. It is produced by distention of the bladder acting on the womb in a particular situation, and is the cause of suppression of the urine. When the womb in the

third or fourth month of gestation has increased so much as to produce a degree of compression on the surrounding parts, and to rise above the brim, and shoot up into the abdomen, a distention of the bladder is apt to throw the fundus under the projection of the sacrum. We have to observe the connection betwixt the back and lower part of the vagina. By the distention of the bladder, the vagina is stretched, and the orifice of the womb is raised, which throws back the fundus of the womb, so that this comes to be the situation of the parts.

Second Plan of the Female Pelvis.



A, the os pubis; B, the sacrum; C, the bladder of urine much distended, and rising above the pubis; D, the connection betwixt the back part of the bladder and the upper part of the vagina, and through which the rising of this part of the bladder (in consequence of its distention) has drawn up the orifice of the womb, and thrown back the fundus. E, the orifice of the womb, which being raised and turned up, no longer presents so as to be felt by the finger in the vagina. It will be observed also, that the womb now lying across the pelvis, this lower part is forced against the neck of the urethra, so as to compress it, and cause total obstruction of urine. F, the va-

gina, which is stretched in consequence of the rising and turning up of the orifice of the womb. G, the fundus of the womb enlarged and distended by impregnation, fallen back under the promontory of the sacrum, and compressing the rectum H.

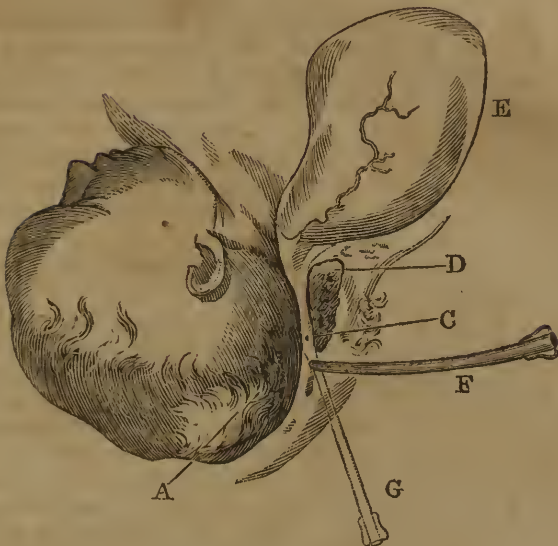
Now, when the fundus of the womb is thrust back, and the orifice raised by the distention and consequent rising of the bladder, the natural and simple cure is to introduce the catheter, and draw off the urine. But should this not be done at first, then there being distention of the bladder, and pressure on the rectum, the abdominal muscles sympathize with these parts, so that bearing-down efforts are made, and the fundus of the womb is forced further down into the hollow of the sacrum, while the orifice is directed upward.

Were this distention to happen at any other time than just when the uterus is of such a size, that being thrown back, it catches under the sacrum, and does not rise again, no harm could follow.—I last year attended, with Mr. Cheyne senior, a woman afflicted with obstruction of urine, who died. I afterwards opened the body, where the womb being enlarged by disease, had produced much the same effect as if it had been enlarged by pregnancy, viz. obstruction of the urethra; for the body of the womb had fallen into the hollow of the sacrum, and had formed adhesions there with the rectum, while the orifice of the womb pressed forward upon the os pubis, so as to produce an obstruction of urine. The parts were otherwise diseased, but this was one cause of the obstinacy and fatal determination of the complaint.

As we treat of those subjects only as connected with the urethra, we may observe, that sometimes the urethra takes a course not round behind the os pubis simply, nor straight upwards, but curved backwards, so that the convexity of the catheter requires to be towards the sacrum, to allow the point to pass over the orifice of the womb, or perhaps the flexible, or the male catheter may be required.

The effect of the wedging of the child's head in a tedious labour, is to elongate and compress the urethra in a very particular manner. Many young men have felt the difficulty of introducing the catheter in this case. But it is a difficulty proceeding generally from ignorance, or inattention. I have never seen a case in which the compression was so great as to prevent the passing of the catheter. But often practitioners forget the direction which the urethra necessarily takes, when the child's head has sunk into the pelvis.

Third Plan of the Female Parts.



Thus, when in the second stage of the labour, the child's head A, has sunk into the pelvis, the urethra C, is pressed betwixt it and the os pubis D. The urine consequently collects in the bladder, and the bladder E, rises above the brim of the pelvis, and I have found it stretching to the scorbiculus cordis. There is danger from the distention of the bladder, and the labour-pains cease. Now the young surgeon or accoucheur, introduces the catheter in the usual way, in the position F, of course he finds great difficulty, and gives pain in the attempts. But after inserting the point of the catheter, he must incline its handle much towards the perineum, as in the inclinations of the dotted lines G, so that the point may glide up in the direction betwixt the child's head and the pelvis.

Orificium vaginæ. This is also named orificium externum, in opposition to the uterine orifice. I notice it under the head of the external parts, because we have to speak of the parts which surround the orifice as the hymen.

The orifice of the vagina of the human female is abridged by the hymen, which is a peculiar membrane. It is of a semi-

lunar form, and sometimes surrounds the lower part of the orifice of the vagina ;—commonly it surrounds only the lower half of the circle, though it would seem to vary considerably in shape, place, and strength. It has been found surrounding the whole circle of the orifice, leaving only a small hole in the centre, or upper part ; or it is described as perforated with lesser holes, allowing the evacuation of the menstrual blood. In other cases, it has been found a complete circle, preventing the evacuation of the menstrual blood. This is a fact which I do not dispute, for I know that the perforation for the evacuation of the menstrual blood is sometimes necessary. When I have seen the imperforated vagina in the child, it was not the hymen which closed the orifice, but an adhesion of its sides; yet this adhesion, if it had come to be distended with the menstrual blood of several periods, would have presented the appearance of a tense membrane stretched across the orifice.

Such a membrane as I have described, will occasionally be seen in the female parts ; but it has such an appearance as may easily be destroyed in the preparation of the parts, if the anatomist be inattentive or careless. It is neither a guard, nor is its existence a test of female chastity. Often in tender children there is no such thing to be seen; while, on the other hand, it has been cut to admit of labour and delivery.* Either of these facts is sufficient proof of the idle notions entertained concerning this membrane. It has been a favourite topic in all ages, and in all situations. The savage, and the gentleman, make much the same enquiries on visiting a museum ; and such was the subject of Omai's speculations in the museum of Dr. Hunter.

THE CARUNCULÆ MYRTIFORMES—are small and irregular tumours at the back, or lower part of the external orifice ; they are seated rather at the sides than exactly at the back part ; they are generally supposed to be the ruins of the hymen, which being lacerated, shrink into two or three tumours on each side. Some have said, that these exist originally joined together by a thin membrane, or delicate tissue of small vessels, the rupture of which causes an effusion of blood. They seem to be simply corrugations of the inner membrane, which serve as a provision for the dilatation of the parts ; and they accordingly disappear during the passing of the child's head.

THE FOSSA NAVICULARIS is a sinus, supposed to be of the shape of a boat, whence its name. It is formed betwixt the

* I need not ſay how unneceſſary and improper ſuch operations are. All rigidity, caloſities, even tumours, and undoubtedly the hymen, will yield to that general relaxation of all the parts, which takes place upon the commencement of labour.

proper orifice of the vagina and the fourchette, or joining of the labiæ at their lower edge. It is more conspicuous in young subjects.

From the meeting of the labiæ below, the PERINEUM commences: it includes that space from the frenum to the anus.

CHAP. II.

OF THE PARTS CONTAINED WITHIN THE FEMALE PELVIS.

THESE parts are the bladder of urine, the vagina, the womb, the ovaria. We shall consider them under distinct sections.

SECTION I.

OF THE BLADDER OF URINE.

As the coats of the bladder of urine in woman do not vary from those of the male bladder, we have under this head only to notice the peculiarities in its relative situation. It is seated behind the os pubis, and betwixt it and the womb; and on its lower part it is attached to the vagina; upon the neck of the bladder, or the beginning of the urethra, there is not a body like the prostate gland; and, as we have seen, the urethra is short, wide, and straight, and simple in its use.

Women are not subject to calculi, and the operation for the stone is rare in them; for, as already observed, when the nucleus is formed, or when a stone slips down from the pelvis of the kidney, it passes from the bladder with much greater facility than in the male parts. The urethra of itself has been known to dilate so, as to allow very large stones to pass, or it has been artificially dilated. Indeed the old operation for lithotomy, was rudely to dilate, or rather tear, the urethra, and the modern operation is simply to thrust the gorget along the

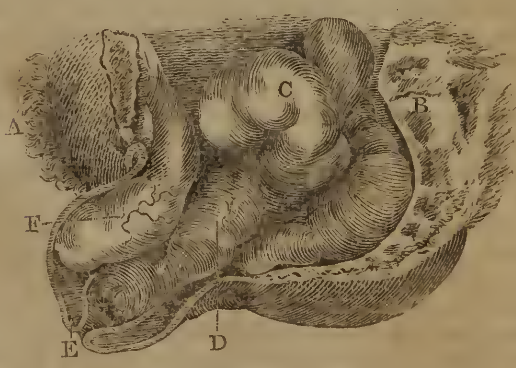
grooved staff, so as to lay open the side of the urethra and neck of the bladder, by an incision above the vagina. Sometimes nature has effected her own relief by the stone working from the neck of the bladder into the vagina.

A woman had for a very long period suffered great distress, not only the ardor urinæ, frequent desire to make urine, with the urine turbid and bloody, and with all the usual symptoms of stone violently aggravated ; but she was delicate and timorous, and concealed her distress until the urine had run for some time by the vagina. After she had been exhausted by long suffering, her friends insisted that she should allow an examination, when a stone was found partly in the bladder, with one of the rough ends projecting into the vagina. The opening was enlarged, and the stone extracted.

We must, in all cases, recollect the connection of the upper part of the vagina and orifice of the womb, with the back part of the bladder. We have seen its effect in producing retroversio uteri. We must also attend to this connection, as tending to the displacement of the bladder in the procedentia uteri. The uterus sinking into the vagina, and the upper part of the vagina being at the same time reflected into the lower part, pulls down the bladder with it, and when (the disease increasing) the womb covered by the vagina comes to hang from the external parts, it has happened that the bladder has sunk down and lain upon the fore part of the tumour, but of course within the everted vagina.

Fourth Plan.

Section shewing the effect of Procedentia on the Bladder.



Thus, by comparing this fourth plan with the first of the female pelvis, we may judge of the nature of this displacement of the womb, and its effects on the bladder of urine.

A, the os pubis; B, the sacrum; C, the intestines come into the situation of the womb; D, the uterus fallen down, and carrying the vagina before it; E, the vagina still covering the womb, but the orifice of the womb appearing, which is generally distorted and irregular; F, the bladder, which, from its attachment to the fore part of the vagina, has been dragged down, but is now within the vagina.

In such displacement of the bladder, the urethra becomes distorted from its natural direction, there is an obstruction of urine, and the catheter is with great difficulty introduced. We shall, perhaps, have to turn the handle of the catheter in various directions after introducing the point, and by chance get it introduced at last.

SECTION II.

OF THE VAGINA; OF ITS SHAPE, CONNECTIONS, ETC.

The vagina is a tube stretching from the external orifice to the orifice of the womb. Its orifice is bounded below by the fourchette; above by the arch of the pubis; and directly over it, or sometimes within it, is the orifice of the urethra; below, are the carunculæ myrtiformes. It is surrounded by fasciculi of fibres, which are called the sphincter muscle. The canal of the vagina is of a conical form. At the outer orifice it is constricted by the sphincter muscle; but it is wider within, and where it receives the orifice of the womb. It may be distended to almost any degree, but naturally its sides, by their own elasticity, or the contraction of the surrounding fibres, or the pressure of the surrounding parts, are in contact.

In the natural state, the orifices of the vagina and womb, are but three or four inches distant, often only two; and sometimes, where there is a degree of relaxation, they are nearly in contact. In the first months of pregnancy, the orifice of the womb is kept down by the degree of difficulty the body of the womb has in shooting up from the brim of the pelvis. But the gravid uterus rising above the pelvis in the latter months, draws up the orifice of the womb, and stretches the vagina.

The vagina bends gently round the pubis as it were, or fol-

lows the axis of the pelvis ; and as the interior of two circles cut off by the same radii is the shorter, the vagina is longer behind than before.

And thus (*in this fifth plan*) the fore part of the vagina A, is shorter than the back part B. We may observe from this plan also, that the orifice of the womb C, projects as it were into the vagina, so that the finger touches the os tincæ, and chiefly its anterior lip, without reaching the upper part of the vagina.

The vagina takes its curve nearly in the centre of the pelvis; it is of necessity attached by cellular substance to the rectum and bladder. The urethra, as we have said, opens above the orifice, and that canal is attached to the vagina in its whole length ; and the neck of the bladder is attached to the upper part. In consequence of this natural connection, disease of the vagina sometimes throws the whole parts, the rectum, vagina, and bladder, into one fistulous ulcer.

The vagina has three coats ; that is to say, it has the inner coat, or surface, a few muscular fibres, and around it a condensation of the surrounding cellular membrane, which may be considered as the third coat.

The internal, or villous coat, is a reflexure of the delicate covering of the external parts. It is of larger extent, or longer than the others ; and is therefore tucked up into rugæ, which run across the vagina. They are more remarkable on the fore and back part of the vagina ; they are less in married women, and considerably obliterated by repeated labours.

To supply a viscous secretion for the defence of this surface,

mucous glands are numerously, but irregularly scattered over it, and they are particularly numerous at the orifice.

The muscular coat is not very strong, nor are the fibres distinct, from which some have suspected their existence, alleging, that there is here only condensed cellular membrane, and that the contraction of the vagina is the effect of mere elasticity. I observe so great a profusion of venous vascularity, that I presume the vagina suffers an inflation of its coats, and consequently contraction from an afflux of blood to it. The muscular fibres are, however, as we have said, gathered into fasciculi near the orifice, so as to be distinctly visible.

The firmness and stricture of the vagina support the womb; the dilatation of the vagina, the relaxation which old age, and frequent labours produce, occasion the falling down of the womb. It is a disease almost peculiar to those who have borne many children, to the old, weak, and relaxed, and to those who are subject to the fluor albus; every flux from the womb, or discharge from the vagina, having a remarkable effect in relaxing the parts.

This, from the nature of the parts, must be an increasing disease; for no sooner has the womb fallen down into the vagina, than it becomes a source of irritation, excites a bearing-down pain-like tenesmus, an uneasy sensation, a desire to make urine, and an obstruction of urine; all which is explained by the connection of the parts. The womb lodging in the vagina dilates the orifice, and presses long on the perineum, at last it is entirely forced out, and the prolapsus uteri becomes the procedentia uteri: it is in truth a hernia of the womb.

The third, and outer coat, as we have said, is formed of the cellular membrane, by which it is connected with the surrounding parts; but the peritoneum comes down upon the upper part of the vagina. This is the reason why a portion of the intestine, when it slips down betwixt the vagina and rectum, forms a kind of hernial tumour in the vagina, and why the water of ascites has pushed down the back of the vagina, so as to make a bag capable of being punctured to draw off the water.

For the greater space, however, the outer cellular coat of the vagina connects it with the urethra on the fore part, and with the rectum behind. From which close connection of parts, we see the consequence of the delay of the child's head in the second stage of labour, that the head lies violently distending, and compressing the parts, while the woman, exhausted by the previous stage, is unable to complete the delivery. From violent inflammation, with a deficiency of secre-

tion, there arises a cold and flabby state of the parts. When the woman is delivered, the parts have suffered so much, that they slough off; sometimes the urethra is laid open on the fore part, and sometimes the rectum behind.

SECTION III.

OF THE WOMB.

6th Plan of the Female Parts.

Uterus & Tubes.

THIS little drawing will better explain the figure of the womb, when dissected from the vagina and surrounding membranes, than the usual necessary reference to a bottle, a pear, or a powder-flask. As, indeed, it strictly resembles no familiar object that I know, we must, for the convenience of description, distinguish it into these parts:—The upper part, or FUNDUS, which is that part above the going off of the Fallopean tubes. The BODY of the uterus, which is that larger part betwixt the fundus and the narrowing below; THE CERVEX, which is the narrow neck; and the OS TINCÆ, or orifice formed of the bulging lips, which project into the vagina, of course that part over which the inner membrane of the vagina is reflected. We distinguish also the two surfaces, for the womb is of a flattened form. The anterior surface of the

body of the womb is convex, but the posterior surface is considerably more so, and even during gestation it keeps this relative figure.

The whole size of the uterus is about three inches in length, and two in breadth, but there is a very great variety in this respect, from age, the effect of pregnancies, and other causes. When, in its usual situation and relations, the fundus is on a level with the brim of the pelvis, or a very little below it. In the fœtus, the womb is like the bladder, considerably above the brim of the pelvis ; but, in a few weeks the pelvis enlarging, it sinks deeper, and soon assumes the same situation as in the adult.

Fallopean tubes. From the lateral obtuse angles formed betwixt the fundus and the body of the uterus, the Fallopean tubes are continued. These tubes may almost be considered as a continuation of the uterus, did not we find them so very distinct in their substance. They are about three inches in length, take a tortuous course, and their extremities have an unequal fringed termination, which is called the fimbriæ*. Their canal is very small towards the uterus, but enlarges, and is patulous towards the extremities. These canals are the communications by which the ovum formed in the ovarium is carried down into the womb.

Ligaments of the uterus. To support the uterus from sinking too deep into the pelvis, and to steady it, and direct it in its ascent during pregnancy, anatomists have generally assigned as the use of the ligaments. But whatever good they may do in the latter operation, they are certainly unfit for the former.

There are four ligaments of the uterus.

The broad ligament of the uterus is formed of the peritoneum ; for this membrane passing down before the rectum, and ascending again, and covering the neck, body, and fundus of the womb, descends on the fore part, so as to reach the vagina before it rises over the bladder. Thus it invests the womb as it does the abdominal viscera. This investing of the womb with the peritoneum is indeed a provision for its becoming an abdominal viscus, for in pregnancy it rises out of the pelvis ; and, being distended before the bowels, assumes in every respect that relation to the peritoneum which they have.

As the womb then is included betwixt the duplicature of the peritoneum, it is this peritoneal coat, which being continued off laterally, forms the broad ligament of the womb. This duplicature of the peritoneum being a thin expansion of it,

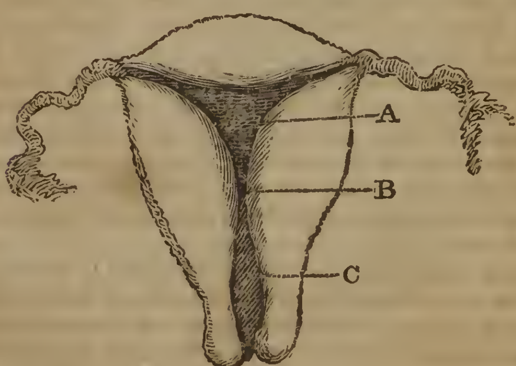
* Morſus diaboli.

has sometimes had the name of ALÆ VISPERTILIONIS: It is in truth like a mysentery to the womb and Fallopean tubes, and serves equally to support and convey the vessels to them. The womb and the two ligaments make a complete partition running across the pelvis.

From the side of the uterus, a little below, and before the going off of the Fallopean tubes, the ROUND LIGAMENTS arise. I consider these ropes as ligaments, but they are totally unlike any common ligament. They seem intended to give the due inclination forward, and to direct the uterus in its ascent in pregnancy, and accordingly they are not merely condensed and unelastic cellular membrane; but, on the contrary, they are composed of fibres, with an intermixture of blood-vessels, so that whilst they keep a degree of tension on the uterus, they yield and grow not only in length, but in thickness and strength, as the uterus ascends in the advanced pregnancy: they pass through the abdominal ring, and are attached to the cellular membrane of the top of the thigh. In the gravid uterus, both the broad and the round ligaments considerably alter their position, appearing to rise lower, and more forward from the womb than in the unimpregnated state. This is in consequence of the greater increase of the fundus of the womb, in proportion to the lower part of it.

OF THE CAVITY OF THE UTERUS.

Sixth Plan.



The cavity of the uterus is properly confined to the fundus and body, and takes a triangular figure. In the cervix, it is more like a canal, and differs essentially from the proper ca-

vity. A, *the cavity of the uterus;* B, *the continued cavity,* where it is very narrow towards the cervix. C, *the canal of the cervix,* where it has an enlargement like a sinus. The Fallopian tubes going off from the cavity of the uterus.—These angles of the cavity admit no more than a hog's bristle. The third angle, towards the neck, is, of course, considerably larger. The proper triangular cavity of the uterus is lined with a peculiar soft and delicate membrane; it is very vascular, and the vessels either open on the surface naturally, or bursting out from time to time, pour out the menstrual blood. The canal of the cervix shows a very different surface. We observe a prominent longitudinal line on the fore and back part of it, from which oblique and transverse rugæ go out. The surface is firmer and callous, and less vascular. Betwixt the rugæ there are lacunæ, which throw out a mucilaginous fluid; and towards the orifice we see these larger, and sometimes distinct glandular bodies.

This peculiar shape of the cavity of the womb, and the hardness and small degree of vascularity of the lower part, is of the most essential importance. The upper part, the proper cavity of the womb, is prepared for the reception and immediate adhesion of the ovum, when it shall have descended through the Fallopian tube; but the long callous cervix is provided, that there may be no adhesion to the lower part of the womb, and that the placenta may not form over the orifice of the womb, for if it should, the most dangerous kind of flooding takes place on the approach of labour from the opening of the orifice, and the tearing open of the adhesions of the placenta, before the child can be delivered. The length of the cervix, and the glandular structure of the orifice is also of much importance in sealing up the cavity of the womb after conception, that there may be no longer communication with the vagina; for this purpose, a viscid tenacious mucus is poured out; but, on the approach of labour, with the softening and relaxation of all the soft parts, this adhesion and gluing up of the orifice is dissolved, and a more fluid secretion is poured out.

From the cavity of the womb the MENSTRUAL BLOOD is discharged at certain periods, from the time of puberty to the approach of old age, when the system is no longer capable of giving nourishment to the fœtus. We shall presently find, that the subserviency of menstruation merely to the preparation of the surface of the womb for the reception of the fœtus, though it be a principal, is by no means the sole end of this periodical discharge.

It was long disputed from what source the menstrual dis-

charge flowed. Some affirmed, that it must flow from the vagina, and not from the womb, because it flowed sometimes during gestation. This is a fact which cannot be denied. I have attended a patient who menstruated during the entire period, or to the eighth month; and I have often observed ladies to menstruate at the first period after conception. On the other hand, we have every proof of the discharge being from the orifice of the womb. For instance, some have observed on dissection of the parts of women dying during the flow of menses, that blood was effused under the delicate membrane of the cavity of the womb. The vessels there have been observed particularly turgid, or the whole surface of the proper cavity, and especially the fundus, spotted with bloody effusions. More particular observation has shewn, not only the mark of blood poured out from the inner surface, but that the whole substance of the womb was become thick, soft, and vascular*; and M. Littre affirms, that in the body of a woman who had died during menstruation, and with a conception in the Fallopian tube, he found a layer of red coagulated blood; upon removing which, he saw a number of small foramina which admitted bristles†.

But the best and least equivocal proof is, that which has been repeatedly observed in the inversion of the womb, when the inner surface has been turned out after labour, and has remained thus inverted, and protruding from the external parts, for then the menstrual blood has been seen to distil from the surface of the cavity of the uterus.

OF THE BLOOD-VESSELS OF THE WOMB.

These are four large arteries which supply the system of the womb, and four large veins which return the blood.

The SPERMATIC ARTERIES come down from the aorta itself, or from the renal or capsular arteries. The spermatic artery taking a waving direction, becomes tortuous in a most remarkable degree as it approaches the uterus, it is distributed to the Fallopian tube, the ovarium, but chiefly to the body and fundus of the uterus, where it forms remarkable anastamoses with the artery of the other side.

The LOWER ARTERY—the UTERINE ARTERY, comes in general from the hypogastric artery, takes also a serpentine course, and is distributed to the vagina, and the lower part of

* The authorities upon this subject are Spigelius, Morgagni, M. Littre, Mouriceaux, Winslow, Sympson.

† This might have been an early abortion, or perhaps the decidua which it is said is sometimes formed at the menstrual period.

the uterus, and inosculates largely with the other vessels, both in the uterus, and by particular branches on the side of the uterus.

In the first place, it appears, that this copious supply of vessels to the uterus, from four different sources, is a provision that the womb and secundines shall not by any accident of position, or by the progress of labour, and the consequent compression of one or both the lower vessels, be deprived of their due supply of blood. Again, their tortuous forms give proof of their occasional greater activity, that they admit of a peculiar and local action during menstruation, and that the blood will move more languidly when the stimulus of the womb has ceased. It is also a provision for the growth and increase of the womb, and the supply of nourishment to the ovum. And that an increased activity in a part must be supplied by a more tortuous form, as well as an enlargement of the calibre of the vessels, is in a particular manner illustrated by the change which takes place in these vessels during pregnancy. For they become in a much more remarkable degree tortuous and enlarged.

The substance of the uterus is said to be spongy and compact, which, though it is a seeming contradiction in words, does yet really convey an idea of the effects of its copious intertexture of vessels. Some have said, (as Moriceaux,) that by pregnancy the womb is distended, and grows thinner: others, that it grows thicker, as Daventer: and others again, as Smellie, assert, that it continues of its natural thickness. These assertions are none of them perfectly correct: for the womb is not distended by the growth of the fœtus and membranes, but grows with them. Again, that the substance of the womb grows in a remarkable degree, is true, but still when distended by the waters in the last months of pregnancy, its walls are thinner than in the unimpregnated state. Thus, when it has been cut in the living body, upon the approach of labour, in the Cæsarean section, I have observed it, not more than a quarter of an inch in thickness, even at the part to which the placenta adhered. When I have dissected the womb after a tedious labour, the waters discharged, but the head wedged in the pelvis, I have found it considerably thicker. And, lastly, in the full contraction of the womb, after expelling the fœtus and placenta, (for example, in rupture of the womb, where the child and placenta had been forced amongst the bowels, and the woman soon after died,) I found the walls of the womb about three quarters of an inch in thickness.

SECTION IV.

OF THE OVARIA.

The ovaria are two oval bodies, which are suspended in the broad ligament behind, and a little below the Fallopian tubes: while they have an oval figure, they are somewhat flattened. By cutting out the ovaria, the animal loses the power of conceiving, and desire is extinguished; they, therefore, bestow what is essential to generation upon the part of the female. In vague speculations on the subject of generation, they were supposed to prepare a female semen! but more particular examination demonstrates, that they consist of vesicles, which are ova; but how far incomplete, or in what essential circumstance requiring the approach of the male, is not determined.

When we hold the section of the ovarium betwixt the eye and the light, we see a great many polluted vesicles; and if we examine the ovarium of an animal killed in full health, and particularly in the season, we shall observe these ova to be in all varieties of states of preparation for impregnation. Some small and pellucid, and yet only discernable in the thick outer coat, by having a degree of greater transparency; others, which have taken a slight tinge of bloody colour from vessels striking into them; and if the section be made after a minute injection, the vesicles will be seen coloured in the proportion of their maturity; some without a speck of colour; others tinged; one or two loaded with injection; and some vascular, and particularly prominent.

In very young girls, the substance of the ovarium is whitish, and very soft; the surrounding membrane is thick; and the round corpuscules scarcely discernable; and no irregularities, nor any of those bodies called corpora lutea, are to be seen on the surface. But as the girl advances in years, the little vesicles begin to appear, and when about ten years of age, or just before menstruation, the ovarium is full of ova of various sizes, and some of them more matured, and forming an eminence upon the surface. In the adult woman, the substance of the ovarium, which appeared as an uniform homogeneous mass in the fœtus, is become a cellular and vascular bed, giving nourishment to those numerous vessels or ova. Before impregnation can take place, there must be a certain state of preparation of the ovaria, without which the approach of the male effects no change in the uterine system. The lower animals having their seasons, and these seasons being a state of preparation for the male, impregnation follows the copulation with much certain-

ty: but, in women, such a periodical revolution in their system, and instinctive desires, would but ill accord with that superiority in attributes of the mind, which distinguish us in the scale of beings. But women also suffer such an occasional excitement in the uterine system, though unaccompanied with desires, which preserves the womb in a state of preparation for the reception of the ovum, and the ovaria in a state of preparation for impregnation. This is the effect of menstruation.

OF PUBERTY.

Authors have long, with many expressions of surprize, laboured to assign a cause, or frame a theory for the explanation of those changes which we observe in woman at the age of puberty: and generally, in their theories, they have connected with these changes the monthly and periodical discharges of blood from the uterus, which commences with puberty. These theories have been founded in general, on principles remote from the laws of a living system. At this period of puberty, the whole frame is expanded into the fullness of feminine beauty; the breasts rapidly increase, and are matured; the parts of generation are enlarged; the hair of the pubes grows, and the menses flow. In explanation of these changes, theoretical conjectures after this model have been entertained. "About this time the growth of the body begins considerably to diminish, and the blood finding easy admittance into the completed viscera is prepared in greater quantity, the appetite being now very sharp in both sexes, a plethora consequently follows. In the male it vents itself frequently by the nose, from the exhaling vessels of the pituitary membrane being dilated, &c.; and now the semen first begins to be secreted, and the beard to grow. But, in the female, the same plethora finds a more easy vent downwards, being that way directed, partly by the weight of the blood itself to the uterine vessels, now much enlarged, of a soft fleecy fabric, seated in a loose hollow part, with a great deal of cellular fabric interspersed, which is very yielding and succulent, as we observe in the womb: for these causes, the vessels being easily distensible, the blood finds a more easy passage through the very soft fleecy exhaling vessels which open into the cavity of the uterus, as being there less resisted than in its return by the veins, or in taking a course through any other part; because, in females, we observe the arteries of the head are both smaller, in proportion, and of a more firm resisting texture. The return of the same is, therefore, more slow, both because the flextures of the arteries, from the in-

creased afflux of the blood, become more serpentine and fit for retarding the blood's motion*, and likewise, because it now returns with difficulty through the veins. The blood is therefore first collected in the vessels of the uterus; next, it is accumulated in the arteries of the loins, and the aorta itself, which urging on a new torrent of blood, augments the force so far as to discharge the red blood into the serous vessels, which at first transmit an increased quantity of warm mucus, afterwards a redish coloured serum, and by suffering a greater distention, they at last emit the red blood itself. The same greater impulse of blood determined to the genitals, drives out the hitherto latent hairs, increases the bulk of the clitoris, dilates the cavernous plexus of the vagina, and whets the female appetite to venery, &c."

We cannot give implicit trust to such speculation, we cannot believe in this plethora, produced by the diminished growth of the limbs; neither can we believe that congestion and plenitude is produced in the female system, from the deficiency of perspiration, from their more lax and weaker solids compared with man, from their indolent and sedentary life: for facts are in direct contradiction. The growth and completed function of parts at this particular age, is not to be explained by any theory so partially applicable; during almost every period of life, there are similar changes taking place in some one part of the body. Parts lie dormant, and are stationary in their growth, which at a particular and stated age of the animal, enlarge and develope themselves by a new and invigorated action. Observe how different the proportions of the fœtus are from those of the adult. We see nature careful to perfect certain parts, as the head and liver, at an early period. We see during early childhood how the parts shoot out, and evolve in due proportion. We see parts which were large in the fœtus lose their preponderance: we see others, which served some purpose in the fœtal system, gradually shrink and disappear, because they have no longer the stimulus to action in the circle of connections which take place in the adult system. We find other parts, as the teeth, for example, lying long within the jaw, instead of proceeding with a gradual and continual enlargement, suddenly rising at certain stated periods from their embryo state, and enlarging and pushing up through the gums, when it becomes fit that the child should take more solid food than the mother's milk. So the second set of teeth, in a more particular manner, lie quite stationary in their growth within

* I have ſhown that the tortuous arteries always form a proviſion for the occaſional increaſe of the action and acceleration of the blood.

their little sacs, yet quickly, at stated periods, they increase, the enamel is formed, and they rise above the gum. There is an infinite number of such changes depending upon the same laws of the œconomy, and not different from those which controul the growth, and direct the shape of parts. They depend upon certain laws of the constitution, which give an excitement to certain parts, at stated periods, and which no theory partially applicable will explain. There is a series in which the parts of an animal body are matured, and a succession in which the functions are brought to maturity: and in the female constitution, there are laws determining an action upon the womb and breasts, and all parts subservient to conception and the nourishment of a fœtus; at that period when the woman is arrived at the age fit to take upon her the part of a mother.

OF MENSTRUATION.

UNDER this head, I shall confine myself to such a general view of the subject, as is necessarily connected with the peculiar functions we are now endeavouring to comprehend.

Menstruation is a state of preparation for conception. When, therefore, the menses flow at the natural periods, and in due quantity, it is a sign that the woman may conceive, and that her system is fit for the support and nourishment of a child. It is a general affection of the system, which has a tendency to relieve itself by a topical action, by the excited action of the uterine system; and this excitement of the uterine system is the end which nature is accomplishing. To explain this, I may be allowed to take a short preliminary view: each particular organ or viscus, whilst it has its connections with the general system, is, in truth, a system within itself, having its peculiar functions, sympathies, and even vascular action, in a certain degree, independently. Were not this in some measure the case, we should see no local disease or topical action; and no vascular action could be for a moment stationary and confined to one part. The body would, indeed, be then only one great hydraulic machine. But while the several parts have the property of being excited separately to an accelerated action, they are actuated by remote sympathies, and by these sympathies and relations, is the whole system in a great measure supported.

Before menstruation commences, there is a preceding indisposition, and symptoms indicating a constitutional affection. And these complaints are usually more severe in the first, than in the subsequent periods. The general revolution in the system begins to accumulate its action towards the womb, and

those symptoms usually accompanying uterine irritation, show how far it is affected, and in a little time the menses flow. Now, I conceive, the flow of the menstrual blood, to be not the end which nature is here labouring to accomplish, but the means of allaying the excited state of the uterine system after the object is accomplished. It is not the discharge of a few ounces of blood which relieves the system ; for drawing blood simply will not do it ; but it is the excited action of the uterine system which relieves the general distress, and that topical action has full relief in the menstrual discharge. General and topical plethora are terms which have been of great service in explaining this periodical change in the female system, but the state of mere fullness, has little effect either on the constitutional or topical change. Even in the exhausted and debilitated state of the system, when menstruation ceases from the want of energy and power in the vascular system, still there remain the same laws governing the sympathies, and relations of the several parts ; and although they are feebly and imperfectly excited, they give rise to accumulated distress at the period in which the menses should flow.

There is more general distress at puberty, and when the menses first flow ; but afterwards, when the periodical action and discharge is established, there is little or no previous indisposition.

With regard to vicarious hæmorrhagy from remote parts of the body, some, whose opinion I greatly value, do not consider them as deviations of the menses. At all events, from what I have seen of such hæmorrhagies (tumours, for example, discharging blood at the menstrual periods), I would observe, that there is an excitement, throbbing, and distention, previous to the discharge of blood, which confirms me in the notion of the necessity of a counter excitement and action, as well as the discharge of blood, being necessary to make a derivation from the uterine vessels. It is by dissection alone that we can form an established opinion regarding the final use of the periodical return of the menses.

By dissection we come to the knowledge of the most essential facts. In the first place it is found, that the ovaria, and their vessels, partaking of the general excitement of the spermatic arteries, are enlarged, full of blood, and with every sign of increased action. We find also, that the ovaria are matured and brought to pubulate, and almost to start from their investing membranes. Again, when we attend to the womb, we find, that these are marks of its whole vascular system being roused to action. It has become laxer in its texture, and there is a change similar to what takes place in

thus prepared, it approaches the ovarium, grasps and receives the ovum, and by a peristaltic motion, probably very slow and gradual, the ovum is conveyed into the cavity of the uterus.

OF THE OVUM, AND ITS CONNECTIONS WITH THE UTERUS IN THE EARLY MONTHS OF PREGNANCY.

The ovum, when it has descended into the uterus, and is perfect in its structure, is a soft oval mass, fringed with vessels, and composed of membranes containing the early fœtus. When opened, or dissected, it presents three cavities, or we observe the fœtus to be surrounded with three distinct membranes. 1. Decidua, or tunica filamentosa, false chorian, or spongy chorian. 2. The chorian. 3. The amnios. Of these coats, the outer one is formed by the womb, the others constitute the ovum as it has descended from the ovarium. We shall, in the first place, attend to the original membranes and general constitution of the ovum, and then to the deciduous covering which it receives in the womb.

Plan of the Membranes.

A, The Fœtus. B, The Amnios. C, The Chorion. D, The Vesicula Alba.

Amnion. The amnion is the vesicle which immediately involves the fœtus. It is a very thin and pellucid membrane in the early stage of pregnancy, but it acquires considerable thickness and strength in the latter months.

The amnion contains a thin watery fluid in which the fœtus is suspended. In the abortion of the early months, we find the quantity of this fluid very great in proportion to the whole

ovum, and this forms a defence to the delicate, and almost gelatinous substance of the fœtus, while it is a provision also for the regular presentation of the head of the child, for now the fœtus being suspended in this fluid, and hanging by the umbilicus, and the head and upper part of the body greatly preponderating, it takes that position with the head presenting to the orifice of the womb which is necessary to natural and safe labour, the fœtus being prevented from shifting in the latter months by the closer embracing of the child by the uterus.

Chorian. The chorian is the second involving membrane of the fœtus; on the inside it is smooth, and betwixt it and the amnion a gelatinous fluid is interposed. In the early months it is much stronger than the amnios, but in the advanced stage it has come in contact with the amnios, no fluid being betwixt them. And in proportion as the amnios gains strength to be of essential service in dilating the orifice of the womb during labour, the chorion has relatively become very thin and weak. On the outside the chorion is shaggy and vascular, and constitutes those minute extremities of the vascular system of the ovum, which attach to the surface of the womb, or rather to the flocculent membrane which it throws out.

The umbilical chord. When we can first discern the fœtus, it is merely like an opaque oval body of the size of a common fly, and closely attached to the amnion; but, by degrees, it recedes from it, and then we perceive that it is attached by the umbilical chord, which consists of the trunk of the vessels going out from the fœtus, and which distributed upon the chorion receive the supplies from the maternal system.

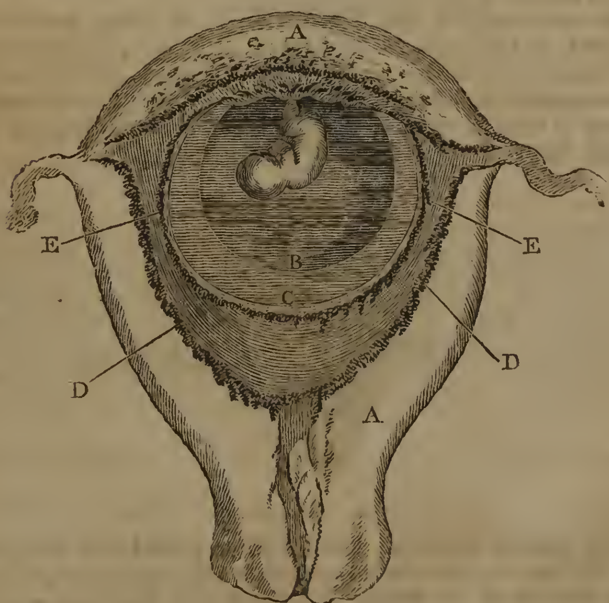
Now we perceive that the fœtal system which descends from the ovarium, is not merely a fœtus or embryo, but that this embryo, besides a system of vessels within its own body, is surrounded completely with membranes, and that from the vascular system of the embryo, there go out vessels, which being minutely distributed to the outer vesicle, or membrane, and actuated by the same heart which circulates the blood through it, our little corporal system prepares for imbibing the due nourishment from the uterus.

Vesicula alba. The vesicula alba, or umbilicalis, is a little vesicle which lies betwixt the chorion and amnion; it contains a white fluid; it is connected with the navel or chord, by an artery and vein. Very little has been offered as explanatory of its use, it has been considered as similar to the alantois of quadrupeds, and having a connection with the urachus; but it has no communication with the bladder, and soon disappears. Whereas, if it had been for receiving the secretion of urine, it would have been prepared for the more mature state of the fœtus.

I conceive it not to be improbable, that it is a provision of supply for the embryo, previous to its perfect attachment to the uterine system, and during its descent into the womb, perhaps similar to the albumen of oviparous animals, but which, after the perfect establishment of the connection betwixt the fœtal and maternal system, shrinks and disappears, as being no longer necessary.

OF THE ADDITIONAL MEMBRANES WHICH THE OVUM RECEIVES FROM THE UTERUS.

WHILE the ovum is taking the changes consequent upon impregnation, the womb partaking of the general sympathy which prevails over the whole uterine system, takes a change adopting it for its reception. The first appearance of action is marked by a greater activity of the vessels, a swelling and softness of its substance. While on the inner surface there is an exudation which being converted into a spongy membrane, is peculiarly adapted for the reception and adhesion of the ragged and vascular surface of the ovum.

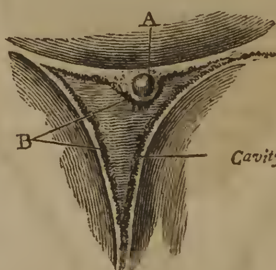


In this plan we shall be able to observe the relations and inflections of the uterine membranes or decidua, as seen and de-

scribed by Dr. Hunter, and of their correctness, my observations in dissection leave no doubt in my mind. AA, The uterus in out-line; B, the amnion with the fœtus; C, the chorion. Now it is observed, upon a careful examination of an abortion of the early months, that besides the chorion and amnion, there is a spongy membrane of two distinct lamina which invests the chorion. The outermost of these is found to surround the whole ovum, even investing that part which has become the placenta by the accumulation of vessels. This outer membrane then may be represented by the line DD. It is represented as adhering to the surface of the womb, as it must do in fact. We observe again, that it is perforated where the Fallopian tube enters the womb, that at this part it is not formed; so that, according to Dr. Hunter, and the preparations which I possess, these tubes open into its inside.

Upon dissecting up the outer lamina of the decidua, we find that where the placenta commences, it is reflected over the surface of the ovum and the shaggy chorion of the ovum, so as to be represented by the letters EE. We shall now understand the distinction betwixt the DECIDUA VERA DD, and the *Decidua Reflexa* EE.

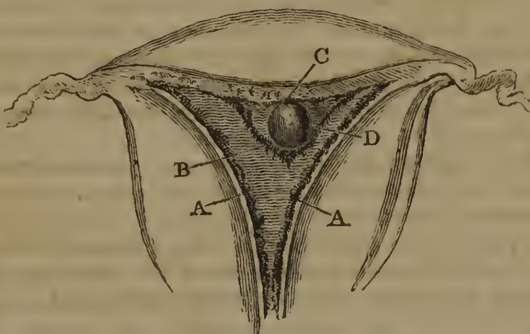
It would appear that this membrane is either completely formed, or at least the fluid which is to form it, is thrown out previous to the descent of the ovum; indeed, so intimate is the sympathy betwixt the whole uterine system, that this membrane is formed in those cases where the ovum does not descend, but constitutes the extra uterine conception.



Dr. Hunter supposed, that the ovum passed into the cavity of the uterus whilst the coagulable lymph was pouring out by the arteries of the uterus, and that it was thus immersed in, and surrounded by the decidua, for he could not conceive that

it could gain admission betwixt the lamina of the membrane already formed.

I should conceive that the ovum A, upon its descent gets intangled behind the deciduous membrane B, by which means the ovum is not left loose in the cavity of the womb, but is soon attached and surrounded with a membrane, or vascular web, from which it can immediately draw supplies, and by this provision also its adhesion to the superior part of the uterus is insured. But as the same action of the uterus continues, and, as we must naturally suppose, be rather occasioned by the presence of the ovum in its cavity, the surface of the uterus at A continues to throw out a coagulable matter which surrounds that part of the ovum, so that this will immediately become its situation.



A, The *Decidua Vera*, formed before the descent of the ovum. B, the *Decidua Reflexa*, formed by the ovum getting behind it, and pushing it down. C, the efflorescence which continued to be poured out, surrounds the upper part of the ovum, and which, from its more immediate supply from the uterus, will in time form the sole support of the fœtus, viz. the uterine portion of the placenta.

Of the placenta, and of the nutrition of the fœtus.

When the ovum first descends into the uterus, the fleecy surface of the chorion establishes a universal adhesion, but no sooner is the attachment of the ovum established, than the vessels of the fœtus which are universally distributed over its surface, begin to accumulate to that point from which the more abundant supply is obtained. Thus, from the universal adhesion the vessels of the fœtus are massed and accumulated to-

gether, so as to form a thick cake or placenta. This takes place upon the same principle that the roots of a plant stretch towards the soil best suited to it, or the branches and leaves of a plant grow and spread towards the light. The placenta is destined to adhere to the fundus of the womb, and there we observe the accumulation of the large vessels of the womb, it being equidistant from the several sources of blood; and to this point is the tendency of the vessels of the chorion so great, that we sometimes see the vessels of the chord running three or four inches upon the membranes before they reach the placenta, evidently shewing that the point to which the umbilical chord had been originally attached, was not opposite to the more vascular part of the womb; but that the vessels had to stretch and elongate some way from the insertion before they accumulate in form of the placenta, towards that part of the uterus where there was the greater vascularity.

But the formation of the placenta on the fundus of the womb is not constant, although there are many provisions for ensuring attachment there. But when it does form low in the womb, or on the orifice itself, we then perceive the reason of nature's solicitous care in preventing it; for it occasions the most dangerous floodings from the placenta presenting on the approach of labour, and its connections being necessarily torn up previous to the delivery of the child.

The placenta of the advanced stage of gestation is a mass formed partly by the accumulations of the vessels of the fœtus (the trunk of which is the umbilical cord), and partly of a vascular and cellular portion formed by the uterus. On the surface attached to the womb, the placenta exhibits deep and irregular fissures which divide it into lobes; but on the inner surface is smooth from the investing membranes, but raised into irregularities by the numerous and tortuous ramifications of the umbilical vessels. When rudely torn or cut into, it appears to be a spongy substance, formed in a great part of an irregular tissue of vessels.

In the human subject we find, that the maternal part of the placenta is thrown off with the other secundines, and does not separate from the fœtal part of it. While, in other viviparous animals, the monkey excepted, the filamentous extremities of the fœtal vessels separate from the glandular mass formed by the maternal vessels of the uterus.

The placentary vessels of the fœtus never touch the surface of the womb, but communicate with the maternal system through the vessels of the womb, which pierce the deciduous membrane. Still the question of the precise manner in which the vessels of the fœtus communicate with those of the mother

remains undetermined. I conceive that in the early stage the deciduous membrane being thrown out by the action of the uterine vessels, those of the chorion stretch into it, and absorb the nourishment. The decidua is a vascular membrane, but it has, at the same time, a peculiar spongy texture. This spongy, or reticulated structure of lamina of the decidua ceases where the placenta is affixed. When we carefully dissect up the decidua to the margin of the placenta, it is found to be more rigid, white, firm, and thick*. When we examine the outside of an entire ovum, we observe that at the place covering the placenta, it is corrugated and full of irregular eminences like the convolutions of the brain, and among those irregularities many small convoluted arteries may be discerned, with spots of extravasation and the flat mouths of veins. Upon dissecting up this maternal part of the placenta, we find it to form the firmest part of it; and by the difference of colour, as well as by the possibility of tearing it up, or dissecting from the mass of vessels of the chorion, we recognize it as the decidua. This union, however, betwixt the maternal and fœtal parts of the placenta is intimate, and it is impossible to determine by dissection with the knife, whether there be inosculations betwixt the maternal and fœtal vessels, or whether the nourishment of the fœtus is by absorption, nor can we distinguish in the first months the cellular intertexture which may be observed in the placenta of the full time, as described by Mr. Hunter.

In explanation of this part of our subject, I have purposely dissected, and made drawings of the ovum in several stages. This point of anatomy relating to the decidua, is particularly explained in Plates VI. and VII. to which I refer the reader.

Of the liquor amnii, as conducing to the nourishment of the fœtus.

Some physiologists observing the strict analogy, which exists between the function of the placenta and the lungs of breathing animals have conceived, that the liquor amnii is the source of nourishment, and that it is taken into the stomach. I believe they have conceived some analogy to exist betwixt the albumen of the egg and the liquor amnii, which in their minds has strengthened this opinion. But there is here no analogy; we have seen, that the embryo of oviparous animals being formed with the yolk in the egg-bed or ovarium, descends into

* I ſpeak after diſſecting the ovum of the third month.

the uterus, and there receives the addition of the albumen or white. On the other hand, we find that the ovum of viviparous animals is formed in the ovarium; and that the liquor amnii being within the membranes of the ovum, must be the production of the fœtal system. Further, when the ovum has descended into the womb, and grown to some maturity, we see that there is no connection by vessels betwixt the fœtus and mother but through the placenta; that the liquor amnii is within the involving membranes of the fœtus, and that consequently it must be thrown out by the vessels of the fœtal system. Thus, to suppose the fœtus to be fed by the liquor amnii, would be to suppose it to draw resources from its own system, and that the vessels poured out a fluid, which is afterwards to be taken into the stomach*. But without adducing arguments, it is sufficient to say, that fœtuses have been brought forth, monstrous in their conformation, and without mouths yet well grown.

Of the placenta as the source of nourishment to the fœtus. When we consider the mere speck of the embryo in the first weeks, we see that it can have no other source of nourishment than through the extreme vessels of the chorion, connected with the short umbilical chord; and we may be convinced also, that in its progress to maturity, when the general connections of the chorion cease, and the placenta is formed, the sole supply is through its vessels. Regarding the manner of the communication betwixt the vessels of the mother and child there are many opinions. The simplest explanation, but the furthest from the truth is, that the arteries of the womb are continued into the veins of the fœtal portion of the placenta. That on the other hand, the arteries of the fœtal system are continued into, or inosculate with the veins of the womb; and that thus, the blood of the mother's system is carried by direct inosculation. A little investigation will convince us, that this is a very unlikely conjecture. We see the embryo surrounded with its vessels, and forming a complete system within itself, descend into the womb. We see that the attachment betwixt the surface of the ovum and the womb, depends on a reciprocal action betwixt them; and when the fœtus is feeble, or diseased, or when it dies, the uterus immediately separates from it, as from a dead part, and there is an abortion. Again, it is not natural to suppose, that the circulating fluids of the adult are calculated for the circulation in the embryo, or

* A greater abſurdity than that of which a foreign author is guilty cannot be imagined, becauſe the liquor amnii, or ſome fluid, is found in the trachia, he ſuppoſes that the fœtus reſpires, and receives oxigination from the liquor amnii.

that the blood of the adult is fit for the circulation of the fœtus. When we inject the vessels of the fœtus, we find the veins and arteries of the umbilical chord to inosculate freely with each other, and the fluid passes from the arteries to the veins with little extravasation or escape of fluid, and such only as may be supposed to pass from torn vessels. Again, the bleeding of the child does not draw from the maternal system; for example, when the accoucheur has to perform the operation of embryoulcia, and when the arteries of the brain pour out their blood, the woman does not suffer, nor is there any danger of hæmorrhagy from the chord after the delivery of the child. Again, what does the analogy of other animals show us? We may observe, in the first place, that probably on account of the peculiar form of the womb of woman, and in these circumstances to guard her from danger of hæmorrhagy during delivery, it is necessary that the placenta should be accumulated towards the fundus of the womb. Now, to allow less danger of the separation of the secundines from the womb, and consequent abortion, there follows a necessity for the human placenta being attached in a particular manner; and in place of the maternal part of the placenta remaining with the womb, as in other animals, the whole mass separates on the delivery of the child. The necessity for this firmer attachment of the human placenta, causes the connection betwixt the fœtal and the maternal portions to be very intimate, and the manner of the vascular connection by no means easily demonstrated.

In other animals, however, for example in those which have the small and numerous placenta, or cotylidones, the fœtal and maternal portions of the placenta separate easily; the maternal part being a prominent vascular bed, which is a part of the womb, and is not deciduous. Here we find, that the glandular-like portion which belongs to the womb may be minutely injected, and no particle of colour pass into the fœtal part; and again injection shows the fœtal portion to be merely composed of the fleecy extremities of vessels, which, however, minutely injected, do not show any inosculations with the maternal vessels; in short, here the connection betwixt the extremities of the two systems is so very loose, and the filaments so minute, and almost like an impalpable mucus, that we can imagine no other kind of connection than that the extremities of the umbilical vessels take up by absorption the nutritious matter necessary for the system of the child, and that this is secreted by the vessels of the womb.

Investigation in every department of natural history shows a similarity, and a simplicity in the operations of nature. Comparative anatomy may be brought with much advantage

in illustration of the very obscure laws which guide the functions of the parts of generation. When we turn our attention to the egg, we find, in the first place, that the vascular system is complete within itself, and requires no permanent connection with the maternal system to invigorate its action. We find that the artery which passes out of the umbilical chord of the chick, and which is distributed to the membranes of the white, pulsates strongly, and carries venous coloured blood. We find the returning vein carrying arterial coloured blood. We find then that these vessels must have a double function, they imbibe the nourishment from the white, and convey it to the increase of the chick; and they at the same time, perform an action similiar to that of the pulmonary vessels of the adult, seeing that they carry out dark-coloured blood, and convey it back to the chick, of a bright vermilion colour. Now, I do not conceive, that this change upon the blood is performed by the communication with the atmosphere through the shell, for I see no distinction in the colour of the vessels, which are contiguous to the membrane of the shell, and those which are removed from it by the expanding of the air-cell. Further we find, that there is an intermediate kind of generation in fishes which are oviparous, but retain the egg within their womb, until the fœtus is matured; here no communication with the air or water can be allowed.

Since we see that the thick in ovo is capable of ministering in every essential particular to its own increase, wherefore should we suppose that the fœtus of viviparous animals has any other more particular connection with the womb of the mother?—The difference is in my mind this simply; the ovum of the oviparous animals descending through the convoluted and intestinal-like womb of the hen, accumulates a quantity of matter around it, which serves every purpose of nutrition when the embryo shall be finally separated from the maternal system; but in the viviparous animals the ovum descending into the womb remains there, and has an incessant supply of nutritious fluid, secreted from the vessels of the womb, as it is required by the appetency of the fœtal system. As in the egg, the membranes surrounding the white have the same effect upon the blood, which is afterwards produced by the lungs; so has the placenta of viviparous animals the double function of supplying nourishment, and the oxigination of their blood. The umbilical vein carries back pure arterial blood, and the common opinion is, that the blood of the fœtus coming in contact with the blood of the maternal system, receives the principle from it, which bestows this quantity of colour, with other necessary qualities, of which this of colour

is but the sign to our observation. It is not necessary to this change on the fœtal blood, that it should come in immediate contact with the maternal blood, for it is possible, nay probable, that the matter thrown out by the maternal vessels, whilst it is nutritious, has also in it, in a condensed, and not a gaseous form, that which is essential to the change of the blood of the fœtus from the modena colour to bright vermilion.

OF THE EXTRA UTERINE CONCEPTION.

We find some curious facts relating to the action and sympathy amongst the parts of generation, proved by the cases of extra uterine conception. When nature, baulked and interrupted in her usual course of operation, shows unusual resources, it would appear, that the ovum, after impregnation, has in some cases remained attached to its original seat in the ovarium, perhaps owing to some want of due sympathy and synchronous action of the Fallopian tubes, which should grasp and receive the ovum. In other instances the ovum has been received into the Fallopian tubes, but either from a want of sufficient dilatation and action in them, they have not been able to propel it forward, or the ovum taking upon it that action which is destined to form its connections with the uterus, adheres, and is enlarged in the tube, so that it cannot be conveyed down into the womb.

But the most curious instance of the extra uterine conception is, where after impregnation the ovum has dropt from the ovarium, and lies in the cavity of the abdomen amongst the viscera. Here also the vessels of the fleecy chorion spread, and attach themselves to the surface of the viscera.

These instances of deviation from the natural action of the parts, after conception, prove to us, I think, that from the moment of impregnation there is a principle of life and activity in the system of vessels of the ovum, and that at a stated period this action becomes such, that the efflorescent vessels of the surface of the ovum, attach themselves to whatever vascular surface they are in contact with. Further, it seems to shew, that in the womb, and in the deciduous membrane which it prepares for the reception of the ovum, there is nothing very particularly necessary, and that any vascular surface will take upon it the same changes, and being excited probably to some peculiarity of action, will in every thing essential supply the growth and nourishment of the ovum and fœtus.

It shows us how far the action previous and consequent to impregnation is a universal and sympathetic excitement of the uterine system; that the decidua is formed in the cavity of the

womb, although the ovum does not descend. This points out to us how careful nature is, that there shall be a reciprocal action in the ovum and womb, so as to ensure the adhesion of the ovum, and the ready supply of a proper nidus for it, when it shall have descended into the cavity of the womb. It informs us, that the uterus is a spongy and vascular bed, having peculiar sympathies which actuate its vessels, and a form of vessels adapted to quick acceleration of action so as to grow, enlarge, and supply the secundines with nourishment.

It is not, however, in the mere adhesion and supply afforded to the fœtus, that the peculiar adaptation of the womb for the reception of the fœtus is shown, but in the provision for the delivery of the child at a regular and stated period. For, it is a curious fact, that in the case of extra-uterine fœtus, on the expiration of the nine months, the uterus takes upon it that action, and that excitement of its muscularity which is destined to expel the fœtus. Accordingly we find, that at the usual time of utero-gestation, there are pains excited, and flooding, with the discharge of the decidua from the womb, although it contains no fœtus.

Nay, further it would appear from the result of several cases, that at the expiration of the natural term of utero-gestation, the fœtus indicates that it is governed by prescribed laws, which render a change necessary, and show that its system is no longer fit to be supplied through the placentary vessels, and as in the situation of extra-uterine fœtus this change cannot take place, it dies and becomes with its secundines, as a load of foreign or dead matter in the belly. This event is generally followed by the death of the mother, though sometimes an abscess has opened and discharged the fœtus, or after much suffering, the bones have been discharged by stool, with much matter and colliquative diarrhœa.

Of the womb at the full period of gestation and of delivery.

To complete this view of the female parts of generation, it remains only to speak of the state of the parts at the full term of nine months, and to observe the process of a natural delivery.

The rapid increase of size of the pregnant womb in the short space of nine months, is perhaps the most surprising phenomenon of the whole animal œconomy, it shows the power of a peculiar excitement in calling into action a partial and local system of vessels. This state of pregnancy is the furthest from a state of distention, in so much, that it is observed the

womb feels peculiarly soft on impregnation, and as if but imperfectly filled by the ovum. This soft state is a sign of vascular action. We may often observe in the discussion of a tumour, that before any change takes place, it swells and becomes soft, and this even where the tumour is about to be absorbed.

The fundus of the uterus is the part first enlarged; and afterwards the inferior parts; at length the cervix is obliterated, and the uterus, which was originally pyriform, becomes nearly oval, and the distention, as we have remarked, is greatest on the back part of the womb. In the first months the uterus sinks lower in the pelvis, they say, from its weight, but the specific weight of the uterus is not increased, and on that account it should not sink deeper; it is, perhaps, rather from its enlargement, and the difficulty with which the fundus makes its way among the viscera in the brim of the pelvis. Having descended considerably, the os tincæ projects further into the vagina, but the fundus continuing to enlarge, at last emerges from the circle of the bones, and then from the conical form of the uterus, it sometimes rises suddenly out of the pelvis; now the vagina will be found elongated, and the os tincæ removed from the point of the finger.

Now the ligaments of the womb direct it forward, and it rises close upon the abdominal paries, and before the bowels; in the first pregnancy it rises almost directly up; in subsequent pregnancies from the greater relaxation of the integuments and the abdominal muscles, it is allowed to fall more forward; about the fourth month of pregnancy, the womb may be felt in the abdomen, and rising out of the pelvis; in the fifth month the fundus is about half-way betwixt the pubes and navel; in the seventh, it is about half-way betwixt the navel and scrobiculous chordis; in the eighth, it is at its highest, and towards the end of the ninth month, it rather subsides. Finally, immediately before labour it descends remarkably, and shifts into the middle of the pelvis, so as fairly to present the orifice of the womb.

The muscularity of the uterus is increasing from the first moment of pregnancy. As the uterus increases in thickness and is distended, the muscular fibres become more distinct, and their power of contraction greater; but what is very particular is the very great muscular efforts made by the womb during labour by these fibres, which have not till that time felt the stimulus to action, or been allowed to contract.

When the period for the approach of labour is arrived, the nature of that viscid secretion which seals up the orifice of the womb is altered, it loses its viscidity, and all the parts are relaxed and prepared for the transmission of the head; even

those rigidities, strictures, or callosities of whatever kind, which would seem to promise an absolute obstruction to the passage of the child, yield and relax previous to labour. The action of the womb is at first feeble, as might be expected, and accoucheurs have marked these stages of a natural labour.

1st. The womb has suffered no diminution of its size; the membranes are entire, and, of course, the contractions of the womb are feeble, because before it is allowed to make some contraction its efforts are not strong. This is a provision for the first stage of labour being slow; by and bye the orifice dilating, the membranes with the waters are felt protruding. The membranes and water is as a soft conical cushion, gently dilating the passage; and in this stage there should be no officious interference While the membranes are entire, both the mother and child are in perfect safety.

2d. The orifice continuing to dilate, and the efforts of the womb increasing, the membranes burst, and the head of the child presses on the orifice; then the womb is allowed to contract: this contraction is a stimulus to greater efforts, and, in a few pains, the head descends into the cavity of the pelvis. The orifice is completely retracted, and there is no longer a mark of division betwixt the womb and the vagina; they are as one canal. If, however, the membranes are burst too early, the labour is not accelerated, but retarded. The orifice is not dilated by the soft and elastic membranes; the head of the child presses broad on the orifice, which becomes rigid, and perhaps inflamed, its dilatation is slow, and the labour tedious. Though from the form of the bones, and particularly by the retiring of the sacrum, there is a provision and guard for the soft parts of the mother against compression by the head; yet nature intends this stage to be short, for it is the period of danger. There is now obstruction of urine and fæces, and the vessels of the parts suffer compression.

3d. Now the head of the child presenting at the orifice of the vagina, forms a third stage; it is the stage of most exquisite suffering: the head is pushed forward during every pain, and recedes again in the absence of pain. An interval of rest precedes this stage, at last the pains return, and the hard head of the child coming to press on the orifice, and the womb coming in close contact with the body of the child, the pains are redoubled in strength. The face of the woman, perhaps, before pale and flat, becomes red and turgid, the eyes gleam, and are inflamed; the pulse becomes quick and hard; and from the exquisite expectation of relief, she looks wildly round on her attendants, losing all reason and recollection; she is frantic, with the most agonizing pain to which the human frame is subject.

Now the occiput of the child begins to project with its wrinkled scalp through the external parts, but nature intends that this also should dilate slowly; the ligaments and os coxigis resist several throes, and direct the head forward under the pubes; at last, after several pains, it rises with a half turn, and is delivered.

4th. The fourth stage, is the delivery of the body and shoulders; and,

5th. The fifth stage, is the delivery of the placenta. The placenta is expelled by a continuation of the same action of the womb, and is part of the natural process. First a flow of the liquor amnii and blood follows the child, and the woman lies for a time exhausted; the extreme pain and excitement having ceased. The womb generally recovers its powers in about twenty minutes, and then there is grinding pain in the belly, and the placenta is detached and expelled, or is pushed down into the vagina.

Thus we have sketched, in the most superficial manner, the progress of a natural labour, with a view merely to explain the general notion of the entire function of the womb, not with that minuteness which the accoucheur would look for in treating the subject. Let us, for an instant, attend to the state of the umbilical chord, and the final contraction of the womb.

I have already observed, that while the membranes are unbroken, the child is safe, that is to say, there is no danger of the compression of the umbilical chord; but when the membranes have burst, and the waters are evacuated, the chord must suffer a degree of compression betwixt the uterus and the child, and there is danger that the chord may fall down before the head, until the head has descended into the brim; as the uterus contracts, and as it were follows the child, the circulation through the placenta must become somewhat difficult, and the usual function corresponding with that of the adult lungs impaired. This must be much more the case when the child is delivered, and the placenta remains in the contracted womb. No doubt nature intends by this, that the function of the placenta shall be gradually diminished, and not suddenly cut off, that the child may feel occasion for the play of the muscles of respiration, and that the function of the lungs may, by degrees, take place of the function of the placenta. When the child is first delivered, the chord pulsates strongly; when the child cries, it becomes feeble; at first, the child has strong and irregular catches of the respiratory muscles, but by and bye it breathes more regularly, and cries lustily. At first the breathing only renders the pulsation of the chord feeble, but presently the pulsation becomes so weak, that it is felt only near the umbilicus,

and it ceases when the regular and interrupted breathing is established, and the crying ceases.

The delivery of the child and placenta is followed by a considerable efflux of blood. But after this there continues a discharge from the uterus, which is called the lochia. It is like the exudation of blood from an extensive wound, in as much as by the contraction of the vessels from which it flows, it becomes serous in a few days, and ceases gradually like a hæmorrhagy.

This open discharge from the womb after delivery, is no doubt a provision against the consequence which would naturally result from the sudden and perfect obstruction, and the activity of the uterine vessels consequent on delivery. By this discharge the activity of the vessels is gradually relieved, and as it is a discharge taking place of the active state of the womb, so the secretion of the milk in the breasts, and the giving of suck, causes the discharge to cease much sooner than it would do if the mother were not the nurse.

OF THE MAMMÆ.

In man and in children of both sexes, there is no mark of the breast, but the little cutaneous papilla, or nipple. These tubercles are, however, surrounded by a zone or disk, of a brownish red colour, the areola.

At puberty, as we have said, the breast of the female becomes protuberant, and those parts which were in miniature, and without action, quickly grow into a firm glandular mass (speaking anatomically). The shape, rotundity and firmness of the gland depends much upon the adipose membrane surrounding and intersecting the glandular body.

The glandular part itself is divided into little masses, which again consist of small granules. These several subdivisions of the glands are closely surrounded by membranes.

The lactiferous ducts are gathered together from these lesser granules, and unite into twelve or fifteen in number of a very considerable size, as they converge towards the root of the nipple. When milk is secreted, the glands are large, a remarkable distention of the ducts also takes place, for they are then become tortuous and varicose, and serve as reservoirs of the milk. Where they pass through the nipple, however, they are again contracted, and open by small pores upon its surface. The nipple is of a spongy and elastic nature, and suffers a distention or erection. When the nipple is contracted, the lactiferous ducts must be compressed, and perhaps coiled together, so

that the milk cannot flow, or flows with difficulty: but by the sucking of the child, the nipple is distended, and the ducts elongated, so that the milk flows. There open upon the areola several superficial or cutaneous glands, which pour out a discharge to defend it and the nipple from excoriation.

Of the arteries, veins, or lymphatics of the mammæ, we need not treat here.

We have many occasions to observe the consent and sympathy which exist betwixt the womb and the breasts. On the first period of the menses, the breasts are much distended. In many women at each return of the discharge, a degree of swelling and shooting pain is felt in them, and the enlargement and shooting pain in the breast, with the darker colour of the areola, is marked as the most prominent sign of pregnancy: with the ceasing of menstruation, which is the cessation of the usual excitement and action of the womb, the breasts contract and are absorbed. Any unusual stimulus or irritation in the womb, as polypus, or cancers, or even prolapsus and excoriation, will affect the breasts, causing them to enlarge and become painful.

When the function of the parts cease, they seem to feel the want of the usual excitement to correct action, and are apt to fall into disease; so it is at least with the womb and mammæ, for at that period of life, when the system is no longer able to support and give nourishment to a child, and these parts subside from their usual action, they often become schirrous or cancerous, and terminate existence by a tedious, painful, and loathsome disease.

PART THE FOURTH.

OF THE LYMPHATIC AND LACTEAL SYSTEMS OF VESSELS.

CHAP. I.

OF THE LYMPHATIC AND LACTEAL SYSTEMS OF VESSELS.

INTRODUCTORY VIEWS.

WE have understood that the red blood circulates in the body, through vessels (the arteries and veins) which have a direct communication at their extremities by inosculation; that although these vessels lie parallel to each other, and extend from the heart to the remotest part of the body, yet the blood is said to pass through the circulation, because it is transmitted from the veins into the arteries through the medium of the heart; and from the extremities of the arteries directly into the veins, returning again to the centre. In this transmission of the blood through continuous tubes, there is in the coats of the vessels an alternation of contraction and relaxation which impels it forward. But besides these arteries and veins carrying the red blood through the body, there are other vessels more remote in their connection with what is generally called the circulating system of vessels.

SECTION I.

OF THE CAPILLARY VESSELS.

The capillary vessels are those extreme branches which are as minute as hairs ; but this, though the literal, is not the general meaning of the term. By capillary vessels is rather understood those branches in which the changes are wrought from the blood, and which are either so minute as not to allow the promiscuous flow of the blood, or possessed of such a degree of irritability and appetency, as only to allow certain parts of that fluid to be transmitted.

It is proved that in the living body there is no exudation ; but no sooner is the animal dead, than the fluids exude from the vessels, the secretions pass through the coats of those receptacles which formerly contained them, and the whole parts partake of an universal colour. From this simple fact, we are led to think that a property exists in the living fibre, which by contraction or some other property repels the fluids. Admitting this, it is very natural to suppose that the fibres, and more particularly the vessels, have a discriminating property ; so that the capillary texture of each organ possesses sensibility, which has its relations to the fluids passing through them, or to be secreted from them.

If we admit this, we may also foresee the explanation of the most puzzling phenomenon of inflammation. Inflammation is the effect of excitement : there is increased action of the arteries ; and by the operation of the same cause, there is a destruction of the natural sensibilities of the capillary vessels, so that they no longer are possessed of their distinguishing sensibility, and they admit the promiscuous passage of the red blood : they become dilated by the action of the arteries, and visibly distended with red blood. The effect is not merely the mechanical derangement of the particles of the blood. The chemical changes which take place in the extreme vessels are disordered, and the blood deposits upon the extreme branches of the nervous system an unusual proportion of irritability ; so that with the redness arising from the circulation of red blood through the hitherto pellucid vessels, in parts not endowed with sensibility, there is acquired an unusual sensibility, and the power of transmitting the sensation to the sensorium. Since we see that in an inflammatory state the pellucid veins transmit red blood, and that this red blood must be supplied by the serous arteries ; then it is proved that answering to the pellucid arteries (in their natural state) there are pellucid veins.

We should acquiesce therefore in the opinion that supposes both the arteries and veins to have pellucid capillary branches answering to each other, collateral to the larger and more palpable anastomosis of their red extremities. These anastomosing branches of the arteries and veins in which the red blood is seen to circulate, perpetuate the flow of the greater part of the blood back to the heart, while the several secretions are performed in the capillary vessels ; but there is no reason to suppose that the fluids sent from the arteries into these pellucid capillary vessels are all poured out in form of secretions : part returns into the extremities of the circulating veins. The secreted fluids and solids are either carried away by ducts into their receptacles, or thrown out from the body: while those fluids which are exuded on the cellular membrane and cavities are re-absorbed by the system of absorbent lymphatics.

We say then that arteries terminate, first, in red veins ; which is proved by the microscope, and by mercurial and other injections ; secondly, in glands ; thirdly, in cells receiving red blood ; fourthly, in lymphatic veins ; fifthly, in exhalents, which pour their fluids into the cellular membrane, cavities, joints, &c. and which fluid is taken up by the valvular lymphatic absorbents.

But these absorbent vessels, of which we are now to treat under the division of lymphatics, do also perform a circulation, in as much as they convey back to the centre of the system the fluids, which have been thrown out from the extremities of the arteries. But as these lymphatic vessels are not continued from the extremities of the arteries as the red veins are, as they imbibe the fluids, which have been thrown out of the other system ; their fluid contents cannot be conveyed through them by the force of the heart and arteries, they must be peculiar in having powers within themselves, first of absorbing, and then of propelling their fluid onward to the heart.

This common property of absorption in the lymphatics, absorbents, and lacteals, and their being connected with the same trunk, occasions their being considered as one system of vessels ; when, in fact, looking upon the general œconomy of the living body, we find them ministering to very different purposes. The one branch of the system, the lymphatics (as we have seen in the introduction to this volume), takes up the matter which has been secreted, and poured out from the arteries, (viz. all the solids and fluids of the body,) and conveys it again into the circulating system. The lacteal vessels on the contrary, are those vessels which opening upon the inner surface of the intestines receive into them the nutritious fluids, prepared by the organs of digestion, and suited to supply the

incessant waste and destruction of the solid and fluid parts of our frame, and which have been absorbed and carried away by the lymphatics. Following this simple view, although the absorbent system be commonly divided into the thoracic duct, lymphatics, lacteals, and glandular apparatus attached to them, I shall throw the present section into the divisions of the lymphatics and of the lacteals.

SECTION II.

OF THE LYMPHATIC SYSTEM IN PARTICULAR.

The lymphatic vessels are tubes whose coats are perfectly pellucid, having a remarkable power of contraction, which causes them to shrink, and disappear, so as to render it difficult to demonstrate them. Indeed they are only to be observed by an eye accustomed to the making of lymphatic injections. They are called LYMPHATICS, or DUCTUS AQUOSI, from their transmitting a fluid colourless as water. When they are distended with their fluids, they show that they possess a very distinct character from the other circulating tubes. They are irregularly distended, knotty, and sometimes like a chain of beads, or little irregular vesicles connected together. This irregularity is owing to their numerous valves, which are semilunar membranes, like those of the veins, and hung across their cavities, so as to catch and interrupt the refluent lymph. They say, in general, that in the space of an inch the lymphatic vessel has three or four pairs of valves. But this bears no certain proportion; for as these vessels run where they are exposed to occasional compression from the surrounding parts, or bear the weight of a high column of fluid, their valves are more frequent. The lymphatics are improperly called cylindrical tubes, since they are irregular from their valves branching and frequent communications. The coats of the lymphatic vessels are the strongest of any in the body; for although extremely thin and pellucid, they give resistance to distention beyond a certain point, and bear a column of mercury which would burst through the valves of veins, and tear the coats of arteries. If there be a muscular coat, and no one ever denied the muscularity of the lymphatics, then we may reckon three coats: First, The inner coat, which is the continuation of the inner tunic of the veins, as may be observed in the opening of the thoracic duct into the left subclavian and left jugular veins. It is smooth and polished, forms duplicatures or valves, and

prevents the transudation of their fluids: it is connected by cellular membrane to the middle coat. Secondly, The muscular or middle coat, which consists chiefly of muscular fibres, which, according to Sheldon, run in every possible direction, though the greater number take the circular direction. And, lastly, the outer coat, which is connected with the general investing cellular membrane. As the inner coat must chiefly form the valves, and as valves possess so wonderful a power of resisting the column of mercury, I should hold that the inner coat is that on which the strength and resistance to distention of the lymphatics depends, though it has been said that it is to the outer coat that they owe this property. The muscularity of these vessels is rather inferred than proved: it is inferred from the unassisted action which they have to perform in pressing the absorbed fluids onward to the heart. Nevertheless we sometimes see the lymphatics of the lower extremities of a colour so red and fleshy, that we may say their muscularity is demonstrable.

The lymphatics seem to possess little elasticity; when they are blown into, they rise with the slightest force, and remain distended, although the passage of the air forward be uninterrupted: whereas, had they considerable elasticity, they would contract and disappear. Indeed, when empty, in the dead body they may be rather said to be collapsed than contracted.—Although the lymphatics can be distended with the slightest inflations, yet when distended, as we have already observed, they firmly resist further dilatation. This is a quality necessary to their valvular structure, for if they were elastic beyond this degree of dilatation, the caliber of the vessel would be occasionally so enlarged as to render the valves incapable of meeting, and of preventing the retrograde movement of the fluids.

SECTION III.

OF TH GLANDS OF THE ABSORBENT SYSTEM.

Every where throughout the body and viscera betwixt the extreme branches of the absorbent system and the trunk, glandular bodies are interposed. Though of various forms they are generally of an oval shape, and they vary in size from the twentieth part of an inch to a full inch in diameter. Sometimes they are segregated,—sometimes accumulated and

clustered together. The colour of those bodies is various in the several parts of the body: in young animals they are redder, and become pale only with age. They are redder and stronger in the outer parts of the body, as in the thigh, axilla, &c. less so within the abdomen and thorax. 2. The latter will not bear so high a column of mercury as the former. The mesenteric glands are said totally to disappear in old age.*

It would appear that the glands of this system are of more importance to young animals than to adults. In the fœtus and in children the lacteal and lymphatic glands are exceedingly numerous; but they shrink or disappear with old age. In the fœtus, indeed, they can be of no very essential use; they are then rather in a state of preparation for the actions necessary in infancy and youth. It is then also that they are most liable to disease, and seem more irritable and ready to inflame, especially in superficial situations. About the age of fourteen or fifteen this disposition is changed, which is commonly said to proceed from the increased vigour of the constitution, and the change which then takes place on the organs of generation. It is rather to be attributed, however, to the diminution of irritability and activity of their vessels in verging to the adult state, which is marked by their comparatively less size, and smaller degree of vascularity. We may further observe that the lymphatic glands, even in the scrophulous diseases, are seldom primarily affected: that they partake of diseased action from the surface, or from an affection of the intestines, or from the absorption of matter. The structure of these glands has not been satisfactorily investigated; or the inquiry is attended with insurmountable difficulties. Some anatomists have said, that they consisted of the convoluted absorbent vessels; others that they are of a cellular structure. When they affirm that these cells are totally distinct from the lymphatic vessels, it is not so easy to understand them: for cells communicating with each other, and into which the lymphatic vessels enter, are very much the same with a series of convoluted, varicose, and irregularly dilated vessels. If we could dissect this series of cells, as Haller did the vesiculæ seminales, we should have represented to us the appearance of a convoluted varicose vessel.

There is a coat of cellular membrane which surrounds the glands. This coat is pervaded by a peculiar fluid which has given rise to some speculation It is observed chiefly in young animals, and is for the most part, though not always, white and milky, and in the glands of the lungs it is of a black-

* By Ruyfch, Morgagni, Haller, Sheldon.

ish colour. This is the fluid which having globules in it, was supposed by Mr. Hewson to be the first stage of the formation of the red globules of the blood. It is distinct from the absorbed fluids, and is a secretion from the arteries. Physiologists have not determined the nature or use of this fluid.

At present there seems no better hypothesis to be offered regarding the use of the lymphatic and lacteal glands, than that they serve to check, controul, and measure the flow of the absorbed fluids into the mass of the blood: without them it appears to me probable that at one time the lymph returning from the body, or at another time the chyle, might flow too rapidly, and in a disproportioned quantity into the veins and heart. But by the check which the glands impose upon this flow, giving a remora and serving as receptacles of the absorbed fluids, those fluids are poured with a more uniform and constant flow upon the heart.

SECTION IV.

ORIGIN OF THE LYMPHATICS, AND OF THE DOCTRINES OF ABSORPTION.

The lymphatics, forming a system of absorbents, we might say, in general, that they take up all the fluids which have been thrown out upon the surfaces of the body. Thus they arise from the surface of the skin; from the surface of the cavities and viscera covered by the pleura and peritoneum; from the cells of the interstitial and adipose membrane, &c. This is the simple use assigned to this system of vessels: but whether they are the only system of absorbents; whether they carry away all the parts of the system, fluids and solids; whether they absorb the muscles, membranes, bones, tendons, &c. of which the solid body consists, is a question requiring severe examination. It cannot be denied that although the system and doctrines of absorption be the most beautiful and interesting, and apparently the simplest in the whole œconomy, yet it is founded on very few facts, while there is much doctrine tacitly acknowledged, which seems in symmetry with the facts and the laws of the œconomy, but which is not founded in absolute proof. We shall first examine the proofs of the lymphatics being the vessels which absorb the fluids of the cavities and surfaces of the body. The animal machine

universally partakes of motion. A principal provision for this mobility of parts, is the looseness of the cellular membrane which every where pervades the body, and supports the vessels and connects the several parts. This interstitial membrane is elastic, and being cellular, to allow of motion, its surface is bedewed with serious exudation. This fluid is perpetually passing from the extremities or sides of the lymphatic arteries or capillaries, into the cellular membrane, and upon all the cavities of the body. The fluid extravasated is called lymph, and some have supposed that it passes through inorganized pores, an expression that is not very intelligible; but if by this is meant (as has sometimes been explained) "accidental pores" in the sides of the vessels, it is a supposition quite improbable and unlikely.* The pores or vessels from which this fluid exudes are called exhalent; and their action is no doubt as completely secretion as that which produces the fluids, which in our wisdom we call more perfect secretions.

That the lymphatics take up the fluids thrown out in the cavities of the body, as the abdomen, thorax, pericardium, &c. there is what nearly amounts to an absolute proof, in comparing the fluids of those cavities with that contained in the vessels, for by the experiments of Hewson it is found that if the fluid moistening the cavities be collected, it will form a jelly when exposed to the air, as the coagulable lymphatic does. Again, if a lymphatic vessel be tied up in a living animal, and then opened so as to allow the fluid to flow into a cup, it will also form a jelly like the coagulable lymph.† The fluid of cavities alters in animals diseased; sometimes retaining its coagulability, and even acquiring stronger powers; sometimes losing it altogether. But what is most essential to

* Dr. Hunter fupported this opinion (Commentareis p. 40,) viz. "that the fluids of cavities were collected by tranfudation, and not thrown out by exhalents;" an opinion which could only have arifen from not correcting the ideas received in making injections in the dead body by the phenomena of the living fyftem. See *Hewfon on the Lymphatic fyftem*, chap. viii. where the opinion of inorganical filtering is fuccefsfully combated.—See also Cruickfhanks.

† But, by difeafe, the fluids in the cavities and cellular membrane is altered. In dropfy, for example, the fluid of the abdomen lofes the property of coagulating on mere expofure; it comes to refemble more the ferum of the blood: this were fufficient proof that the collection is not owing merely to the diminifhed abforption, but that there is a change of action in the veffels of the peritoneum, pleura, pericardium, &c. An inflammatory action of the veffels will throw out a fluid more coagulable, and which, in a high degree of action, will form a film of coagulable lymph or even pus on the furface. But in a ftate the reverfe of inflammation, fuch for example as the debility following inflammation, a ferous effufion will be poured out, having little tendency to coagulate.

our present purpose, it has been observed, that whatever change takes place in the fluids of the cavities, the same is found to have taken place in the lymphatics.

But the student naturally asks, how is the lymph taken into the lymphatic vessels; and here it must be confessed, there is too much field for conjecture.

It was thought formerly that the lymphatic arteries terminated in small pellucid veins: these veins carrying only the thinner, and refusing the red part of the blood, were called lymphatics. When the anatomist threw in his minute injection, and saw the coloured fluid return by the red veins, and the colourless fluid return by the lymphatics,* it was held as a sufficient proof of the accuracy of the pre-conceived notion, and tallied with observations of Leewenhoeck, and the theory of Boerhaave. See Introduction to Vol. III. When, however, anatomists more carefully examined the state of parts, they found that the lymphatics were not filled, unless the cellular membrane was previously injected by the extravasation of the fluid from the blood vessels. Finding that this alleged experiment was really no proof of the anastomosis, and direct communication betwixt the extreme arteries and lymphatics, they conceived that it was a proof that these lymphatics took their rise from the cellular interstitial texture. Then injecting with mercury, they found that when the vessels burst, and the column suddenly descended, and the cellular membrane was filled, the mercury was seen to rise in the lymphatics. Following up this, they blew air, or injected various fluids directly into the cellular membrane, and injected the lymphatics. Thus by an error, by an accidental effect of their injection, the minds of Dr. Hunter and Monro were opened to a freer discussion of the received opinions and approved authorities. Soon, however, it was understood by those conversant with anatomy, that these accidental injections of the lymphatics did not prove the lymphatics to take their origin either from the cells or from the extreme arteries; but already this good effect, at least, was produced, that men's minds were excited to inquire after new facts and trains of observations. It was now recollected, that a strict analogy and correspondence subsisted betwixt the lymphatics and lacteals; the proofs of the lacteals being absorbents, were re-called to memory; new proofs of their being the sole absorbents of the intestines were brought forward; the nature of the fluids effused into the various cavities and cells of the body was attended to; and the conviction followed, that the most essential use of the lymphatic vessels was to serve as

* It was probably Nuck who first injected the lymphatics from the arteries.

a system of absorbents, to take up the extravasated fluids. They reflected that to distend the intestines with injection would never fill the lacteals; and were convinced that the injection of the lymphatics could not be supposed to be through the proper absorbing mouths of these vessels opening upon the cells; but rather that the injection had entered the vessels by the rupture of their extreme branches. Thus the *theory* of the lymphatics being a system of absorbents, came to rest on analogy, and the observation of the phenomena of the living body.

The chief proof of the lymphatic absorption has been derived from the manner in which the venereal virus is received into the system. Venereal matter being allowed to lodge upon the delicate skin of the glans penis or preputium, causes an ulcer there. The matter of this ulcer is absorbed by the lymphatic of the part; an inflamed line is sometimes to be traced into the groin; and the lymphatic gland of the groin receiving this absorbed matter, inflames and forms the bubo. Here, then, is a proof that the red veins do not absorb, and that lymphatics do: else why are they inflamed, and why are the lymphatic glands inflamed to suppuration?

We must observe, however, that this is by no means an absolute proof of absorption; nor is there here unequivocal evidence of venereal matter having been absorbed. Although, therefore, we believe in the general system, we may hazard these queries:—If this matter is absorbed, why is there no infection without ulcer (chancre) of the glands? If this ulcer be produced by absorption, how comes it that the constitution is not infected by the first absorption of the matter, and before it has formed an ulcer? Is it not probable that the irritation of the venereal matter, lodging on this vascular surface, and without being absorbed, causes a peculiar inflammation, the tendency of which is to form a pustule, and to produce matter similar to that which originally infected the part with the specific and peculiar action? Again it will be said, however the venereal pustule was originally produced, it appears evident that the absorption of this matter, the conveying of it along the lymphatic, inflames the vessel, and the next lymphatic gland into which it enters, receiving the venereal matter, inflames and suppurates, &c. But again, I choose to say, with every show of likelihood, that neither is this a proof of absorption; but that the lymphatic vessel being very irritable, and always receiving its stimulus to action from its extremities, it has partaken of the venereal inflammation; that this inflammation has been propagated to the gland; that, the gland being formed of the convoluted lymphatic vessels, the effect of this inflammatory action is then accumulated to so great a degree as to destroy

the function of the gland and lead to suppuration.* And further, that the disease is received into the constitution only in consequence of the system at large partaking of the irritation (a word which but imperfectly expresses the change) of the local action of vessels. Matter might be absorbed and taken into the constitution, and the disease propagated according to the common explanation; but, according to that offered here, there must be a primary and local disease, from which the general affection is propagated. If we are to take the inflammation and hardening of the lymphatics and axillary glands as a symptom of absorption from a diseased mamma, we must acknowledge the same proof in evidence of the veins absorbing: for although the lymphatics are more active, and their activity depends on the state of their origins and extreme branches, more irritable, more vascular (I will venture to say), and more liable to inflammation than the veins; yet are the veins affected in a way that would as unequivocally prove them to be absorbents, for we see how they enlarge around a diseased breast, become prominent and hard, and lose their softness and elasticity. But, as we would not say that this is a proof of absorption by the veins, neither is the proof unequivocal that there is absorption by the lymphatics. Again, a suppurating stump, with bad inflammation, will cause inflammation of the lymphatics, and suppuration in the glands of the groin;† a proof of absorption of the matter of the stump: but we do not find that from such a stump the veins ascend, inflamed and suppurating, while sometimes a chain of abscesses is formed for a considerable extent. This, we can have no doubt, is the effect of the inflammation continued along the vessel; and is not the inflammation produced precisely in the same way in the lymphatic?

I found my opinion of the lymphatics being absorbents,—first, on the circumstance that their structure is adapted to this action; secondly, on the analogy between them and the lacteals, in which absorption is proved; thirdly and lastly, upon their continuing to receive and transmit their fluids, after the heart and arteries have ceased to beat, and the red blood to circulate: for then how can they act, but by their own powers? How can they receive fluids, but by absorption? Finally, this phenomenon shows in the lymphatics, a greater

* If a chancre be indolent, although matter be formed in it, no bubo will be produced: but if the surgeon applies some corrosive dressing, which, instead of entirely destroying the diseased spot, inflames it, then will the gland in the groin sympathise and rise into a bubo.

† See Hunter's Commentaries.

degree of irritability, and stronger principle of activity and tenacity of life, than actuates any other set of vessels.

OF THE ABSORPTION OF SOLIDS.

On examining the works which within the last forty years have contributed to throw light on this subject, we at once acknowledge how necessary it is for that part of a systematic book of anatomy, which professes to treat of absorption, to take the form of a critical inquiry. When the absorption of the fluids of the cellular substance, or in the cavities, was universally assented to, physiologists did not make sufficient distinction betwixt the absorption of the fluid thrown out of the influence of the circulating vessels, and that matter which continued to be involved in the membranes and vessels, and which formed the solid part of our frame. It will readily be allowed that the fluid thrown out upon the surfaces of the body and in the cells, might be absorbed without inferring that every part of the body, solids and fluids, were also taken up by the lymphatic absorbent vessels. But physiologists observing that the solid parts of the body were suffering perpetual change; that the whole body and the vessels themselves were formed, decomposed, and carried away; they hesitated not to attribute this to the deposition from the arteries, and the absorption by the lymphatics. This alternate destruction and renovation of parts, the perpetual change which the whole body suffers, has been universally acknowledged and attributed in part to the operation of the lymphatic system, without any other proof than a slight analogy.

The interstitial fluids, and the fluid in the cavities, is imbibed by the absorbing mouths of the lymphatics on the surface of the membranes; but where is the analogy between this and the destruction of solid parts? It has been said that the absorbents eat down the solids, and nibble like the mouth of a worm! a conjecture, the falsity of which is equal to its apparent absurdity. The solids are raised by the agency of the vessels on the chemical affinities of the circulating fluids. They must be resolved by their decomposition, reducing them again to the state of fluids; or the secreting vessels throw out fluids which dissolve them: an operation anterior to their absorption. From the comparative simplicity of the fluids of the circulating vessels, and that in the absorbents, we are authorized to conclude, that as from the blood the several secretions, solids, and fluids are formed; these fluids, before they are again taken into the active system of vessels, are resolved into their original simple and constituent parts. Thus we are

not to look for the matter of the component parts of the body in the absorbing system of vessels more than in the blood, from which these parts were originally formed.

Upon this subject I conceive, that the absorption of the solids depends but in a limited degree on the agency of the lymphatics ; and that there is a necessary change in the aggregation of the matter previous to the absorption by the mouths of the lymphatic vessels.

EXAMINATION OF SOME OPINIONS OF MR. HUNTER ON THE SUBJECT OF ABSORPTION OF SOLIDS.

Mr. Hunter says that his conception of the matter is, that nature leaves little to chance ; and that the whole operation of absorption is performed by an action in the mouths of the absorbents. Physiologists have laboured, he observes, to explain absorption on the principle of capillary attraction, because it was familiar ; but as they were still under the necessity of supposing action in the vessels after the matter was absorbed, they might as well have carried this action to the mouths of these vessels.

One never could have ventured to suppose the extravagant conclusion to which this idea, once entertained, has led Mr. Hunter.—He proceeds to consider the many kinds of solids the lymphatics have to carry away, and the variety of mouths in different animals, suited to the great variety of substances they have to work upon, and then draws the conclusion, or leaves his reader to do so ; that not only are the mouths of the lymphatics calculated to absorb fluids ; not only do they carry away the solids, but each vessel, according to the hardness and toughness of the material upon which it has to operate, has a mouth adapted for the work. Here we do not see the genius of Hunter, but a poverty of imagination

Mr. Hunter takes the merit of a new doctrine relating to absorption.—He admits that oil, fat, and earth of bones had always been considered as subject to absorption ; and that some other parts of the body liable to waste had been supposed to suffer by absorption ; but that any solid part should be absorbed, he supposes to be entirely a new doctrine.—Now, I think we may venture to affirm, that not only was it known that solid parts of the body were taken away during life ; but that physiologists knew each and every part of the living body to be undergoing a perpetual decay and renovation. Nay, we may venture further to say, that Mr. Hunter did not comprehend, in its full extent, the relation in which the secreting and absorb-

ing vessels stand to each other. He is fond of calling the absorbents, modellers,—“ modellers of the original construction of the body,”—“ modellers of the form of the body while growing.” No doubt he understood that such terms from their novelty would be acceptable to minds incapable of real conviction, or of receiving or appreciating a new fact or idea. Mr. Hunter could contemplate no change in the body during growth, decay, or disease, where there was an alteration of form or quantity of matter, without attributing it to the “ modelling absorption.”—A bone cannot be removed without absorption; nor a part which is useless to the œconomy (as the alveoli of the teeth, the ductus arteriosus, the membrana pupillaris, the thymus gland) diminished in size or totally carried away, without the absorbents being in action. This is undoubtedly true; but in regard to the manner in which it is performed we cannot agree with Mr. Hunter. When it becomes necessary that some part should be removed, it is evident that nature, in order to effect this, must not only confer a new activity on the absorbents, but must throw the part to be absorbed into such a state as to yield to this operation. This is the only animal power capable of producing such effects; and like all other operations of the machine, it arises from *stimulus* or irritation, &c. Now, this appears to be the fundamental error of Mr. Hunter's doctrine. I conceive that the absorption of parts in the natural action of health or in disease, is not owing to increased stimulus, but often to a diminution of it.

Does it not strike us forcibly that when a gland swells, and leeches and blisters are applied, and it subsides, there can be no means of exciting absorption; that when pressure is made on a part, and that part is absorbed, this is a strange way of stimulating? Or when we bleed, is it not odd that this should give new power to the lymphatic system? for these are the means of giving a counter irritation, and of suppressing action.

Mr. Hunter has given to the lymphatics not only the grovelling qualities of animals, as eating; but the higher attributes of intellect. They do nothing without forethought and intention; when they absorb, it is because they have found the parts useless in the œconomy. He has carried this notion so far, that he does not only speak of the absorption of the thymus gland, membrana pupillaris, alveoli of the teeth, &c. but of the body in fever as a consequence of its becoming useless when under disease!—The following may perhaps appear to be the more natural supposition:

In a living body we may observe the agency of the nervous, vascular, and absorbing systems: and the phenomena of life

are not to be attributed to any one, but to the whole of these. We must also observe, that life, or the mutual action of parts producing the phenomena of life, is proceeding from excitement, and as in the whole system, so in the individual parts of the body, the healthy action depends on the influence of this excitement to action. The tendency of the growth of the body to peculiar forms, and the increase of parts in disease are produced by it. It acts upon the vascular system in disease, by producing increased action and secretion; as a muscle, in the use of frequent and strong action, will become more fleshy and vascular; as a gland, will be excited to greater action and more profuse discharge, whilst it enlarges and swells up. When a part enlarges in consequence of the stimulus to increased action, either arising from the natural law of the constitution or from disease, it proceeds from the secreting vessels preponderating over the absorbing vessels. There is a deposition of matter which the latter are unable to take away. But diminish this action of the arteries, or take away their excitement, or cause an excitement of some neighbouring part, and thereby subdue their action, relieve them of their fulness, and the absorbents regain their proportioned actions, and the part subsides. The parts of the body, which, in the natural changes from youth to age, are absorbed and carried away, are those in which there is no longer the stimulus to vigorous action, and of course the lymphatics preponderate over the power of the secreting vessels, and the part gradually diminishes, loses its apparent vascularity, loses its redness, and is at last totally absorbed. And as the tooth of a child lies long hid under the jaw, where it partakes of the stimulus to the action of its vessels, grows, and rises up, and the alveoli, partaking of this natural excitement, also form around it; so when the tooth decays and falls out, the alveoli will also decay and be absorbed; because the moment these vessels have ceased to partake of the increased action, their absorbents, though acting with no greater powers than formerly, do yet so preponderate, that a gradual wasting is the consequence. Thus we have to consider not the action of the absorbents merely, but the relation which their action has to that of the arteries.

I should conclude that a part which has ceased to be of use in the œconomy and is absorbed, has not been carried away by the stimulus applied to the modelling lymphatics; but in consequence of a want of the usual excitement of the parts to action, and of the consequent preponderance of the action of the lymphatics; not by an increase of their action, but by a greater uniformity of action, less dependent on the state of excitement of the part. This more uniform state of action, or

lesser degree of dependence on excitement, will not be denied when we see them continuing their action after the death of the animal, and after the other phenomena of life have ceased. As to the absorption of the body in general from disease, as in fever, it appears to be simply the effect of the continued absorption, while neither the organs for digesting and assimilating new matter, nor the vascular system for conveying the fluids, are in a state to minister to the wants of the system, but suffer under an unusual irritation, which disorders their function.

As to pressure causing absorption and producing the wasting of parts, I cannot agree with Mr. Hunter in supposing that the lymphatics are here excited to action; but should rather infer that the nerves of the parts being benumbed, and the action of the arteries suppressed, the lymphatics continue to do their office, while the arteries are prevented from depositing new matter.—For example, when we see a curvature of the spine, from a habitual inclination of the body to one side, and consequently greater pressure on the one side of the bodies of the vertebra: it is natural, at first sight, to say, since the one side of the vertebra is of its natural depth, and the other diminished, that the side which is deep has remained, but the other side has been absorbed; but, when we inquire a little deeper into the phenomenon, which has taken place, we recollect that the matter of bone is undergoing a perpetual change, and that the matter of both sides of the vertebra is changed; we see that the pressure may not have excited the vessels to greater action so as to cause absorption; but that the pressure has prevented the deposition of new matter, when the old was taken away in the natural rotine of the system.

Mr. Hunter has assigned five causes of absorption, which I conceive may be very naturally resolved into one.—These are, 1, parts being pressed; 2, parts being irritated; 3, parts being weakened; 4, parts being rendered useless; 5, parts becoming dead: of the first we have already spoken; the second I should deny, unless when it resolves into the third; for irritation does not cause absorption, unless when it is to an extent sufficient to destroy the natural action and weaken the part. The third and fourth come under the effect of the loss of the natural and accustomed stimulus to action in the arterial system, which of course gives a preponderance to the absorbents: of the fifth we can have nothing to add illustrative of the living system.

CHAP. II.

OF THE COURSE OF THE LYMPHATICS.

THE lymphatics, in their course and relation to the fascia and muscles of the extremities, bear a great analogy to the veins; for there are two sets or grand divisions,—the DEEP LYMPHATICS which accompany the arteries in their branchings amongst the muscles; and the SUPERFICIAL set which accompany the external veins.

SECTION I.

OF THE FOOT, LEG, AND THIGH. Even in the toes the same distinction of the origins of the lymphatics may be observed, as in the limb. For while a plexus covers the toes superficially, and runs up upon the foot with the veins, deeper branches accompany the arteries on the side of the toes. When we observe the course and origins of the greater and lesser saphena vein, we cannot fail to understand the course of the several sets or divisions of the lymphatics of the foot and legs.

From the toes, dorsum, and edges of the foot, the lymphatics climb up the leg in four classes. 1. One takes a course from the root of the great toe and inside of the foot, over the tendons of the great toe and tibialis anticus tendon. It then passes on the inside of the tendon of the tibialis anticus muscle, and before the head of the tibia, following the principal branch of the great saphena vein; and then continues its course in company with the saphena to the inside of the knee. 2. There is at the same time a considerable number of lymphatics, taking their origin from nearly the same place, viz. the inside of the foot, and before the inner ankle; but they take a different course on the leg from the last class; for they pass behind the lower head of the tibia: they now attach themselves to some branch of the saphena vein, and join the former set on the inside of the knee. From this they ascend

superficially above the fascia to the glands of the groin. 3. From the outside of the foot there ascend several lymphatics; a division of which passes before the outer ankle and across the tibia to join the lymphatics, parasites of the great saphena vein, and here they sometimes form plexus and contortions; others turn in behind the outer ancle, and join the branches accompanying the lesser saphena.

The lymphatics which turn round behind the outer ankle pass on the outside of the tendo achillis; and accompanying the lesser saphena vein, sink into thè popliteal hollow. Here they unite with the lymphatics which have accompanied the several arteries of the leg and foot, and particularly the posterior tibial artery.

Popliteal glands. The glands of the ham-string cavity are generally three in number, and very small. They receive the lymphatics, which pass with the internal tibial artery and with the lesser saphena, and they of course swell and become inflamed in consequence of sores on the calf of the leg, outside of the foot, and sole of the foot.

From the popliteal glands there ascend two large lymphatics, which accompany the popliteal artery and venæ comites, and ascend with the latter through the adductor magnus to the fore part of the thigh. They run irregularly, or form a kind of network round the great vessels. On the fore part of the thigh, and still deep, they (or at least some of the principal trunks) enter the lower and deep inguinal glands, or emerging, they pass into the outward glands of the groin. Sometimes these deep lymphatics, instead of being accumulated into larger trunks, divide into many branches, and only unite in the glands of the groin.

Inguinal glands. The inguinal glands are in number from five to ten; they lie involved in cellular membrane on the outside of the femoral ligament. Some of them are superficial and moveable under the integuments; some involved in the laminæ of the fascia, descending from the abdominal muscles; some are close on the femoral artery and vein, and under the fascia. Nearer to the pubes may be observed a division of these glands which belong to the lymphatics of the penis, perineum, &c.

The greater cluster of glands on the top of the thigh becomes affected from disease of the integuments on the fore part and inside of the thigh and leg; and of that part of the foot where the great saphena vein commences; nay, further, the inguinal glands swell from sores of the buttocks, about the anus and private parts. They will even swell from disease of the testicle; but this only by sympathy.

LYMPHATICS OF THE PARTS OF GENERATION IN BOTH SEXES. From the penis there run backwards two sets of lymphatics: superficial ones, which take a course to the groin; and deeper ones, which take a course along the arteries of the penis into the pelvis, or under the arch of the pubis. The superficial lymphatics are the cutaneous vessels, and take their origin from the prepuce, and it is these which, either absorbing the venereal matter of chancre, or sympathizing with the venereal action, form sometimes an inflamed line along the penis, and cause the bubo in the groin. But as there are two sets of lymphatics, the chancre may be in a place where the deep-seated vessels are the absorbents, and consequently the constitution is contaminated without any bubo in the groin; and indeed it has been observed, that a venereal ulcer of the prepuce will, in general, produce bubo, when an ulcer of the glands will not.* When the tract of the matter is through the deep lymphatics which enter the pelvis from below, the gland through which the vessels pass, is not inflamed to form a bubo; neither do the lymphatic glands within the ligament of the thigh inflame to the extent of forming a bubo, either from chancre or from bubo in the groin. This, says a celebrated anatomist, Mr. Cruickshanks, is very fortunate; for if the external iliac glands, like the inguinal glands, should suppurate, they could not be opened by the lancet, they must be left to themselves; they might burst; the pus might fall into the cavity of the abdomen; might produce peritoneal inflammation; and might probably destroy the patient. Now, there appears no reason to dread any such catastrophe. The matter of these glands would form an abscess, which, like other abscesses in the track of these vessels, would fall down upon the thigh. The fact, however, is curious; that when the lymphatics diseased enter one set of glands, there will be no bubo; when they take a course to the other, they inflame and suppurate. This I believe may be explained, from considering the position of the inguinal glands, as being immediately under the skin: for experience shows that a part near the surface will inflame and proceed to suppuration much more readily than a part deep seated, though suffering from the same degree of excitement.

In the external parts of woman (by Mr. Cruickshanks's observation) there are also two sets of lymphatics. Those near the clitoris pass up in a direction to the ring; and those from the lower part of the vulva and perineum to the glands of the groin.

LYMPHATICS AND GLANDS WITHIN THE LIGAMENT OF THE

* Cruickſhanks, page 138.

THIGH. The vasa efferentia of the inguinal glands are in number from two to six. The deep lymphatics which accompany the femoral vein and artery, lying under the cellular membrane, pass under the ligament, and soon form a large net-work of vessels accompanying the iliac vessels, in which they are joined by the branches of lymphatics from the superficial glands; sometimes the trunks accompanying the great vessels of the thigh pass into a gland, immediately within the ligament; sometimes one or two of them only enter into the glands high in the loins; nay, sometimes a large vessel passes on directly to the thoracic duct.

From six to eight or ten glands are seated in the tract of the external iliac vessels under the name of EXTERNAL ILIAC GLANDS. And upon the inside of the brim of the pelvis, and on the hypogastric vessels, the glands are called the INTERNAL ILIAC GLANDS. In proportion to the frequency of disease in the pelvis, these external iliac glands, being in the tract of the lymphatics of the private parts and rectum, &c. are particularly subject to disease. Those glands also which are called SACRAL GLANDS, as lying on the meso-rectum, and in the hollow of the sacrum, have been observed to be often diseased. On the psoas muscle, and on the loins it is impossible to trace the vessels as single trunks; we may observe that one net-work of vessels ascends upon each psoas muscle from the thigh; that there it is joined by the lymphatics of the pelvis. These vessels are in a manner united by those which cover the prominency of the sacrum, and pass under the bifurcation of the aorta. The two GREAT LUMBAR plexus of lymphatics continuing their ascent, many of the vessels enter into the lumbar glands; and on the loins they are joined by the absorbents of the testicle. By the union of the lymphatics ascending from the right and left side, with several large trunks of the lacteals from the root of the mesentery, the thoracic duct is formed on the third and fourth vertebra of the loins.

OF THE LYMPHATICS OF THE ARM.

IN the arm, as in the leg and thigh, there are two sets of lymphatics:—the superficial, and deep seated. The first of these accompany the cutaneous veins, the latter the deep arteries.

As in general there are two great veins on the fore arm, the basilic and cephalic veins; but particularly as the veins which gather into the basilic trunk, on the inner and lower edge of the fore arm, are the larger and more numerous class; so it is found that the course of the more numerous class of lymphatics is on the lower and inner side of the fore arm, and that

they accumulate about the basilic vein. These are derived from the palm of the hand, and from the ulnar edge of the hand. This set sometimes passes into glands, seated on the brachial artery, near the inner condyle of the humerus.

The absorbents which accompany the cephalic vein, arise from the sides of the thumb and fore finger upon the back of the hand; they run on the radial edge of the arm, with the veins which ascend to form the cephalic vein. From the bend of the arm these vessels take a course on the outer edge of the biceps, and then get betwixt the inner edge of the deltoid, and outer edge of the pectoral muscles; they then pass under the clavicle, and descend into the axillary glands. This set of absorbents receive the branches from the outside of the arm in their whole course.

There are absorbents arising from the back of the hand, next the little finger, which following some of the branches of the basilic vein (a larger branch of which is called the ulnaris externa) turn round the ulnar edge of the arm, are inserted into a gland, very commonly found before and a little above the inner condyle of the humerus. From this gland a large lymphatic passes upwards, and attaching itself to the brachial artery, splits and plays around it.

The deep-seated lymphatics of the arm accompany the arteries in the same manner as the venæ comites do; in general two with each artery. They all terminate in the glands of the axilla, and can require no particular description. The lymphatics, from the muscles and integuments on the back of the shoulder, also turn round and enter into the glands of the axilla.

The GLANDS OF THE ARM are small, and irregularly placed in the course of the humeral artery, from the condyle to the axilla. They are from three to six in number.

The GLANDS OF THE AXILLA are large and numerous; they receive the lymphatics from the arm, breast, and shoulder*; they lie in the deep cavity of the axilla, formed by the tendons of the pectoralis major, and latissimus dorsi muscles. They are imbedded in a loose cellular membrane, which, while it surrounds and supports the vessels of the axilla in the motions of the joint, gives them strength from its elasticity. These glands do not all surround the axillary artery; but a lower cluster is attached to the branches of the subscapular artery, going forward on the side of the chest, and to the thora-

* "They even receive abſorbents from the cavity of the cheſt and I have known them ſwell from pleuriſy, peripneumony, and pulmonary conſumption." Cruickſhanks.

cic arteries. These it is which, indurating from cancer of the breast, require so frequently to be extirpated. These glands of the axilla greatly inlarging close upon the artery and plexus of nerves, so as to preclude the possibility of an operation; they compress the veins and benumb the arm by pressure upon the nerves. When they suppurate, they cause a condensation of the cellular membrane which surrounds them, and in consequence, a compression of the axillary nerves and a shrinking of the arm.

When a wound or puncture, such as that which the student of anatomy may receive in the dissecting room, has been made on the little or ring finger, the red lines which often appear in consequence of it, have taken the course of the ulnar edge of the fore arm, and terminated in the inside of the arm, near the condyle; in some instances they have been continued even into the axilla. If venereal matter is absorbed at any point of the hand, near the little or ring finger, or by those fingers, the gland on the inner condyle of the humerus, or some one in the course of the brachial artery, will most probably inflame and form a bubo, and the surgeon will be aware of this absorption; but if the venereal matter be absorbed on the thumb or fore-finger, it is possible that it may not pass into the glands until it comes into the inside of the clavicle. These glands being out of our sight and feeling, the patient may be infected without the surgeon suspecting it*.

LYMPHATICS OF THE HEAD AND NECK.

Of the absorbents of the brain, little is known precisely; but none can deny the probability, next to an absolute assurance and demonstration, that the arteries, veins, and lymphatics bear the same relations in the brain as in the other parts of the system. Lymphatic glands are observed in the course of the internal jugular vein, and even in the foramen caroticum, which are understood to belong to the lymphatics of the brain. The lymphatics of the head are to be observed in the course of the temporal and occipital arteries, which last terminate in glands, seated behind the mastoid process of the temporal bone. The lymphatics of the face have been observed very numerous accompanying the facial and temporal arteries. But those from the internal parts of the face and nose accompany the internal maxillary artery, and fall into the glands under the parotid, or in the course of that artery. These glands are consequently liable to disease, in consequence of absorption of

* Cruickſhanks, p. 182.

matter from the face, throat, and nose, and their extirpation is a very hazardous operation. The lymphatics from the gums and jaws also accompany the internal maxillary artery, and emerge under the angle of the jaw; and some of them joining the external jugular vein, pass through glands near the top of the shoulder. The lymphatic vessels from the tongue and parts about the os hyoides, take also the same course. The GLANDS about the FACE and JAWS are of the greatest importance to the surgeon, for nothing is more common than the necessity of cutting out indurated lymphatic glands. These are sometimes mistaken for diseased salivary glands; now the salivary glands are rarely diseased, the lymphatic glands often. And it will be a guide to the surgeon to inquire into the original cause of the induration, (perhaps a suppuration in the throat, nose, or jaws) and to know precisely the gland diseased, its depth, and connections.

On the side of the face, there are in general several small lymphatic glands on the buccinator muscle immersed in the surface of the parotid gland, under the zigomatic process. There are also glands to be carefully noted, which lie under the tip of the parotid gland, where it extends behind the angle of the jaw, and also lying under the base of the jaw-bone, close to the sub-maxillary gland, and on the course of the facial artery.

The GLANDS and ABSORBENTS of the neck are very numerous, and the latter form an intricate and beautiful plexus, several branches of which are to be observed accompanying the external and internal jugular veins. Some of the glands lie immediately under the skin, and in the cellular membrane, on the outer edge of the platisma myoides; many under that muscle, and in the course of the external jugular vein. But there are many seated deep, for the greater number accompany the internal carotid artery, and internal jugular vein or their branches.

The lymphatics of the THYROID GLAND have been raised by Mr. Cruickshanks, by plunging a lancet at random into the substance of the gland, and blowing into it, or throwing quicksilver into its cellular membrane. The trunks of these lymphatics join the thoracic duct on the left side; and on the right side the right trunk, just as it is about to enter into the veins.

OF THE TRUNKS OF THE ABSORBENT SYSTEM.

THE larger and proper trunk of the lymphatic system, is generally called the THORACIC DUCT, because it was first ob-

served by Pecquet* to be a vessel which conveyed the chyle through the diaphragm, and which took its course through the whole length of the thorax, to throw its fluids into the veins near the heart. Before his time the lacteals which were discovered by Asellius†, were supposed to terminate in the liver. The first discoverers of the thoracic duct, described it as beginning from a pyriform bag, to which they gave the name of RECEPTACULUM CHYLI. In dogs, fish, and the turtle, such a cistern or bag may be observed; but in the human body nothing further is to be observed than an irregular dilatation of this vessel, like a varicose distention, where it receives the accession of the lacteals from the root of the mesentery. The origin of this great trunk, called the thoracic trunk, is the union of the vessels, which running by the side of the common iliac vessels, are derived from the pelvis and lower extremities. Upon the third and fourth vertebræ, and under the aorta this trunk is frequently joined by a large trunk of the lacteals, and then ascending, it receives the greater number, or the larger trunks of the lacteals. On the vertebræ of the loins, the thoracic duct is by no means regular, either in its course or size or shape; often it contracts, and again irregularly dilates, as it seems to emerge from under the aorta. On the uppermost vertebra of the loins, the thoracic duct lies under the right crus of the diaphragm, and then passing the septum with the aorta, it gets on the right anterior surface of the spine, and runs up betwixt the aorta and the vena azygos; it then passes under the arch of the aorta, and there it is considerably enlarged, from the contracted state which it assumes in the thorax. Sometimes it splits, and again unites on the vertebræ of the back. Having passed the arch of the aorta, it crosses to the left side of the spine, and we look for it under the pleura on the left side of the œsophagus.

The thoracic duct now emerges from the thorax, and lies deep in the lower part of the neck, behind the lower thyroid artery, and on the longus colli muscle.

It gets above the level of the subclavian vein of the left side, and here it receives the absorbents of the head and neck (of the left side), and descends again with a curve, and terminates in the angle of the union of the subclavian vein and jugular vein of the left side.

Sometimes there are two thoracic ducts; but this is very rare. Sometimes the duct splits near its termination, and the two

* In the year 1651.

† In the year 1622.—About the year 1652, the other branches of the ſyſtem, which take their courſe to every part of the body, were discovered by Rudbeck, Jolyffe, and Thom. Bartholin.

branches enter the veins separately; but, in general, when it splits in this manner, it again unites before it terminates in the vein.

There is constantly a trunk in the anterior mediastinum under the sternum, as large as the thoracic duct itself, which is sometimes inserted into the termination of the thoracic duct; sometimes into the trunk of the absorbents of the left side, to be immediately described *.

THE TRUNK OF THE ABSORBENTS OF THE RIGHT SIDE.

THE absorbents, from the right side of the head and neck, and from the right arm, do not run across the neck, to unite with the great trunk of the system; they have an equal opportunity of dropping their contents into the angle betwixt the right subclavian and jugular vein. These vessels then uniting, form a trunk which is little more than an inch, nay, sometimes not a quarter of an inch in length, but which has nearly as great a diameter as the proper trunk of the left side.

This vessel lies upon the right subclavian vein, and receives a very considerable number of lymphatic vessels: not only does it receive the lymphatics, from the right side of the head, thyroid gland, neck, &c. and the lymphatics of the arm; but it receives also those from the right side of the thorax and diaphragm, from the lungs of this side, and from the parts supplied by the mammary artery. Both in this and in the great trunk there are many valves.

OF THE LACTEALS AND LYMPHATICS OF THE INTESTINAL CANAL.

We have already remarked the great length of the intestinal canal, the effect of the imperfect valvular structure, in extending the inner coat to a great length: we have remarked also, that while every surface of the body secretes, it is at the same time an absorbing surface; and finally, that while we chiefly contemplate the intestinal canal, as imbibing and receiving the nourishment, we must not forget that it is also a secreting surface of the first importance to the œconomy. But at present we have merely to understand that structure and organization, by which this canal absorbs the nutritious fluid, the chyle, from the food.

In the first place, as to the terms lacteals and lymphatics, we presume that the absorbents throughout the whole length of

* Cruickſhanks.

the canal have the same structure and use ; and that the term lacteals has been suggested merely by the colour of the fluid, which is absorbed from the small intestines. At one time these lacteals convey a milky fluid: at another a transparent fluid, like that which the stomach and great intestines in general absorb.

The lacteals, as it is natural to suppose, were the first discovered of any part of the system of absorbents ; or, at least, they were first understood to form a part of an absorbing system. For although Eustachius, a Roman anatomist, discovered the thoracic duct in the year 1563, yet he had very imperfect notions of its importance, and the discovery was very little attended to, till after the discovery of the lacteals by Asellius in 1622. This anatomist, in opening living animals, to observe the motion of the diaphragm, observed white filaments on the mesentery, which he took at first for nerves ; but, on puncturing them, and observing them to discharge their contents and to collapse, he proclaimed his discovery of a new set of vessels—a fourth kind.*

Had Asellius only chanced to observe these vessels, his merit would have been inconsiderable ; but he also investigated and announced their peculiar office, viz. of absorbing the chyle from the intestinal canal, and carrying it into the blood.

For some time, however, after the discovery of the vasa lactea, the opinion of Hippocrates and Galen, viz. that the mesenteric veins absorbed the chyle from the intestines, and conveyed it to the liver, still prevailed. Even after the discovery of the lacteals was known and received, a part of the old system was still retained, and it was supposed that those vessels carried the fluids absorbed from the intestines into the liver ; and that the fluids were there converted into blood.

About twenty years after the discovery of Asellius, Rudbeck, a Swede, and Bartholin, a Danish anatomist, saw Asellius's vessels in many other parts of the body ; discovered the trunk of the system, and showed that the lacteals did not pass to the liver, but that they were branches of a great and distinct system ; they also demonstrated the unity of this system.

We have seen from this sketch that the ancients supposed the veins of the intestines to be absorbents ; and even after the discovery of the lacteals, this idea has been retained by some of the best modern anatomists, and principally by Haller, and professor Mickel, of Berlin. If the veins absorb from the surface of the intestines, their doctrine would imply that they are also absorbents in general throughout the body. Although

* The nerves being counted as veſſels.

Bartholin, in his epistle to Harvey, had asserted and given sufficient proof that the mesenteric veins were not absorbents, yet the controversy was left in so undecided a state, as to give occasion to the series of experiments in the school of the Hunters, which seems to have put the question to rest, in as far as it is connected with the lymphatic system.*

We have already mentioned that Asellius was employed in opening the belly of a living dog, when he first discovered the lacteals. He perceived upon the surface of the intestines and mesentery a great many small threads, which at first sight, he took for nerves, but soon discovered his error; and to dissipate his doubt, opened one of the largest white chords, when no sooner had the incision been made, than he saw a fluid like milk or cream issue from the vessels. Asellius says he could not contain his joy at the sight of this phenomenon; and turning himself to Alexander Tadinus, and the senator Septalius, who were present, he invited them to enjoy the spectacle; but his pleasure, he adds, was of short duration, for the dog died, and the vessels disappeared. The natural and simple narration of Asellius represents his astonishment, and gives an idea of the sensation, which the anatomist experiences in the instant of making an interesting discovery.†

ORIGIN OF THE LACTEALS. When the young anatomical student ties the mesenteric vessels of an animal recently killed, and finds the lacteals gradually swell; when he finds them turgid, if the animal has had a full meal, and if he has allowed time for the chyle to descend into the small intestines—and empty, or containing only a limpid fluid if the animal has wanted food; he has sufficient proof that these are the vessels destined to absorb the nutritious fluids from the intestines. Again, when coloured fluids are thrown into the intestines of a living animal, and they are absorbed, he has sufficient proof of their free and ready communication with the inner surface of the gut; but the actual demonstration of the absorbing mouths of the lacteal vessels is difficult and precarious. The difficulty arises from these vessels being in general empty in the dead body; from the impossibility of injecting them from trunk to branch in consequence of their valves; and, lastly, from their orifices never being patent, except in a state of excitement. The anatomist must therefore watch his opportunity when a man has been suddenly cut off in health, and after a full meal. Then the villi of the inner coat may be seen turgid with chyle, and their structure may be examined. Perhaps the first obser-

* See the VEINS in this Volume.

† Sheldon, Portal.

vations which were made upon this subject by Lieberkuhn, are still the best and the most accurate.

The villi are apparently of a cellular structure, for although they are flat or conical, or like filaments when collapsed; yet when minutely injected, and especially when they are full of chyle, they take a globular form, and are called the AMPULLULÆ. Their distention, in consequence of a minute injection of the veins or arteries, is probably owing to a cellular structure (which they seem to have) into which the injection has extravasated. The most probable account of the structure of these ampullulæ is that this cellular structure is a provision for their inflation and erection by the blood, when excited by the presence of the chyle in the intestines; that this erection gives rigidity to the orifice of the lacteals; and that the first step of absorption is by capillary attraction, while the further propulsion of the fluid in the extreme absorbents is by the contraction of their coats excited by the presence of the fluid. Thus the absorption is not by an inorganized pore, but depending on excitement and action.

Lieberkuhn's observations of the villi are the most accurate and curious. He observes, that having opened and washed a portion of the small intestine, its whole surface will be found covered with little pendulant conical membranes of the fifth part of a line in size, and the bases of which almost touch each other. From the vascular membrane, to which they are attached, he observes there is given off to each villus a branch of a lacteal, an artery, a vein, and a nerve. He found it difficult by injection to show both the vein and artery, the fluid passed so easily from the one into the other. He found that the extreme branch of the lacteal was distended into a little vessel within the villus. And on the apex of which, with the microscope, he saw one or sometimes several openings; with his glasses he observed the arteries to ramify on the globules or ampullulæ and again collect into veins; and he supposed that still more minute branches plunged into the centre. But he made a still more minute observation than this. Insulating a piece of intestine betwixt two rings, only leaving a space for the entrance of the ramification of the artery which supplied it, he injected with a column, and examined its progress at the same time with his microscope. As he raised the tube, he saw the artery going in serpentine turns to the villus, and the injection returning by the veins; at last it passed into the ampulla lactea, distended it and made its exit by the foramina. He prepared the villi in another way:—he inflated the ampullæ, and kept them so until they dried; then he cut them with a razor, and found them cellular. This cellular structure

Cruickshanks thinks is the common cellular substance, uniting the vessels of the villus. When this gentleman examined the villi of a patient who died suddenly after a meal, he observed some of them to be turgid with chyle, so that nothing of the ramifications of the arteries or veins were to be observed ; the whole appeared as one white vessel without any red lines, pores, or orifices ; others of the villi contained chyle in a less proportion ; and here the ramifications of the veins were numerous, and prevailed by their redness over the whiteness of the villi.

In some hundred villi he saw the trunk of a lacteal forming by radiated branches, one branch in each villus. Mr. Cruickshank and Dr. Hunter counted fifteen or twenty orifices in some of the villi.

Mr. Cruickshank has remarked a deep and a superficial set of lacteals on the intestines ; but for this division there seems no necessity. Deep in the coats the lacteals seem to accompany the blood vessels ; but when they get more superficial, they take a course longitudinally on the canal, and turn deviously, or after running a little way, take a sudden turn towards the mesentery.

As the greater frequency of the valvulæ conniventes in the jejunum, greatly increase the extent of its inner surface of the gut, and consequently give a greater extent of origin to the lacteals ; and, as here the chyle must be in the greater quantity, so the lacteals of this portion of the gut are larger and more numerous than in any other part of the extent of the canal.

The lacteals do not attach themselves to the vessels of the mesentery, but take a course individually, or forming plexus. Before they enter the mesenteric glands, they have been called lacteals of the first order ; when they emerge from the first into the second glands, secondary lacteals, and glands of the second order. The manner of the entering and going out of glands is exactly the same with that of the lymphatics. The lacteals (or perhaps we should now say the absorbents merely) of the great intestines, are smaller and less numerous than those of the small intestines ; for although the intestines be large, still their inner surface is by no means so extensive : besides the chyle is absorbed, and the contents altered before they have descended into the great intestines. Both Winslow and Haller, however, assert, that they have seen chyle in the absorbents of the great intestines. We know that the lacteals absorb chyle, when it is presented to them : while at other times they absorb different fluids. That the absorbents of the great intestines imbibe the fluid contents is evident, from the

change produced on the fæces in their passage. Copious and nutritious injections have been given, which did not return in the same liquid form, and which have supported the strength for some time. Clysters of turpentine give the urine a smell of violets; and the Peruvian bark has cured fever, when given by the rectum.

The absorbents of the stomach form three divisions: one set accompany the coronary artery and vein, and enter the glands on the lesser curvature and omentum minus. Those of the second set accompany the left gastro-epiploic artery, and are joined by the lymphatics of the omentum. The third pass down upon the upper part of the duodenum following the arteria gastrica dextra: these descend to pass into the same class of glands, which receive the lymphatics of the liver. They are joined in their course by the lymphatics of the right side of the omentum.

The lacteals on the mesentery pass from one gland to another till they form one or two large trunks only. These accompany the trunk of the superior mesenteric artery, and run down on the right side of the aorta, and join the thoracic duct. The absorbents, from the rectum and colon of the left side, pass into their glands, or sometimes into the lumbar glands, and join the thoracic duct separately; those from the right side of the colon join or mingle with the lacteals in the root of the mesentery.

OF THE REMAINING ABSORBENTS OF THE SOLID VISCERA.

Where the lymphatics of the lower extremity descend over the brim of the pelvis, they are joined by the absorbents of the bladder, vesiculæ seminales, and other parts in the pelvis: small glands belonging to this set are attached to the internal iliac vessels. In the female, the lower set of lymphatics, from the womb and vagina, also come by this route to join those of the lower extremity, or run mingling with them. Another set of lymphatics of the womb pass up with the spermatic vessels.

The lymphatics of the TESTICLE are very numerous. They come in distinct sets from the body of the testicle, from the epididimis, and from the tunica vaginalis: then reaching the chord, form six or ten trunks, and run up direct to the abdominal ring; passing the ring, they turn outward, and then pass over the psoas muscle and into the lumbar glands.

The lymphatics of the KIDNEY are in two sets, superficial and deep seated; but the former are seldom to be observed. Sometimes disease makes them distinct. The internal lym-

phatics are demonstrated by blowing into the veins, or tying a ligature and kneading the substance of the kidney with the fingers; when they rise, they are seen attached to the emulgent vessels, and go to join the lumbar glands, or terminate in large lymphatics near the aorta.

It is needless to repeat that the absorbents of the spleen are deep and superficial,—for this arrangement is general. Emerging from the spleen, the lymphatics pass along the splenic vessels, and enter into glands attached to the splenic artery in its whole course. In this course they receive the absorbents from the pancreas, and near the head of the pancreas, they are blended with those of the liver, and with them join the thoracic duct.

The lymphatics of the liver are the most easily detected, and may be injected, to greater minuteness, than in any other part of the body. Although they have many valves, yet they do not seem to close the vessels entirely, nor interrupt the mercury from passing from trunk to branch. The superficial lymphatics, which are so numerous that we may sometimes see the mercury in them covering completely a considerable space, have free communication with the internal set of vessels which are also numerous and large. The principal route of the lymphatics of the upper surface of the liver, is by the broad ligament: these perforating the diaphragm join the trunk, which we have noticed under the sternum, and in the anterior medeastinum. It would appear, however, that these lymphatics of the broad or suspensory ligament, are by no means constant and uniform in their course; for sometimes they run down towards the lacteal ligament, and perforate it there; sometimes they pass down into the thoracic duct while still in the belly. Other lymphatics of great size, run off from the convex surface of the liver upon the lateral ligaments, and pierce the diaphragm. The lymphatics on the lower or concave surface of the liver are more irregular than those of the convex side. They unite with the deep lymphatics coming out of the porta along with the vena portæ, enter into the glands, which are seated on the trunk of that vessel, and join the thoracic duct near the root of the superior mesenteric artery.

The lymphatics of the LUNGS are nearly as numerous as those of the liver; but, indeed, in regard to this expression, it is more in relation to the facility of injecting and demonstrating the lymphatics, than to their comparative number. For example, if the lymphatics of the other viscera could be injected to as great minuteness as those of the liver, we should cease to consider that viscus as more abundantly supplied than other parts. The superficial lymphatics of the lungs form areolæ,

and cover the surface almost completely. They take a course to the root of the lungs, where they are joined by the deep seated vessels, and together pass into the bronchial glands, and here the lymphatics of both sides freely communicate.

The glands of the lungs are constantly found both before and behind the bifurcation of the trachea: often these glands are of a very dark colour; nay, their substance is sometimes found resolved as it were into a sac of inky-like fluid. Upon the arch of the aorta, and the root of its great branches, are the CARDIAC GLANDS, which receive the lymphatics from the heart. The absorbents of the heart are small, but very numerous, and their larger branches attach themselves to the coronary vessels. They then pass to the cardiac glands, and mingling with those from the lungs, join the thoracic duct.

APPENDIX;

CONTAINING THE

DESCRIPTION OF THE VENOUS SYSTEM AND THE ANATOMY OF THE TEETH.

CHAP. I.

OF THE VEINS IN GENERAL.

THE veins are those vessels by which the blood carried outward by the arteries, is returned to the heart. The system of the veins however is not so simple as that of the arteries, for while there are only two great arteries carrying the blood from the heart, viz. the aorta and the pulmonic artery, there are three great trunks of the veins, viz. the superior and inferior vena cava, the trunks of the great veins of the body; the pulmonic vein, which returns the blood to the heart from the circulation through the lungs; and the vena portæ, which collects the blood of the intestines, and conveys it to the liver. There are besides, a greater variety in the distribution of the veins, than in that of the arteries.

The French physiologists have departed from the old method of Harvey, in explaining the circulation. He wisely took the heart as the centre of the system, and described the vessels going out from it, forming the two circulations, viz. through the body and through the lungs; but they have assumed the lungs as the centre; and the veins of the body, and the arteries of the lungs, they call *systeme à sang noir*, because it contains the dark coloured blood; and the pulmonic veins and the arterial system of the body, they call *systeme a sang rouge*, because it conveys blood of the bright vermilion colour.

This conceit is perhaps admissible, when introduced as an

illustration of the relation of the lungs to the body; but in the general announcing of the system, and considered as a basis of demonstration, it gives to a difficult subject an unusual degree of intricacy in the mind of the young student: besides, the arteries and veins of the body, and the pulmonic artery and vein, have that strict and mutual dépendence in action, which shows how improper and how unnatural it is to make this change, and to separate them in explaining the general system. At all events, let those who adopt this novelty cease to speak of the two circulations, for although in regard to the heart, there are two circulations, yet as the movement of the blood respects the lungs, there is only one. By this division, the blood returning from the body and carried into the lungs, cannot be called a circulation; but only when it has passed through the lungs, and returned to the same point of its course through the body.

GENERAL CHARACTER OF THE VEINS.—The capacity of the veins, is larger than that of the arteries; the coats thinner but stronger comparatively, and admitting of much dilatation. The coats of the lesser veins, are comparatively stronger than those of the larger ones, and the veins of the lower extremity much thicker and stronger, than in the upper parts of the body, as they bear a higher column of blood. The veins are transparent and the blood is seen through their coats. There can be properly distinguished, only two coats in the veins; the outer coat, which is flocculent and cellular without, to connect with the surrounding parts, smoother and more compact within, where it is united with the inner coat. In it are ramified the vasa vasorum; and a fibrous structure is to be observed in some of the larger and superficial trunks; the striæ or fibres running longitudinally. The inner coat is firm and compact and intimately united to the other; it is smooth, flexible, and formed into valves in various parts.

In all the larger veins, excepting those of the viscera of the abdomen, and those of the lungs and brain, there are valves: these valves consist of the inner coat, forming folds like a semilunar curtain, hung across the calibre of the vein; but at the same time attached so obliquely to the side of the vein, that they present a sacculated membrane to receive the refluent blood. The loose margin of the valve is somewhat stronger than the other part, and betwixt the duplicature some splendid little filaments are sometimes observed. Each valve consists in general, of two semilunar membranes, the margins of which, falling together, prevent the blood from passing retrograde; but they yield and collapse to the side of the vein by the current of blood flowing towards the heart, As the veins

are provided with valves only where they are exposed to occasional pressure, and particularly to the compression of the muscles; their chief use would seem to be, to prevent the retrograde movement of the blood, from the occasional compression of the veins; but no doubt, they at the same time support the column of blood, as in the lower extremities: and when those veins suffer distention by disease, a great aggravation is, that the valves lose their action, become too small to close the dilated vein, and the whole column of blood presses upon the veins of the legs.

The commencement of the minute branches of the veins, is from the extreme ramifications of the arteries; they are continuous, and perpetuate the motion of the blood in that course which is called the circulation. In contemplating the capillary tissue of vessels, the most striking circumstance is, the predominance of the dark venous ramifications: and in general, two sets of veins will even in these minute ramifications, be observed; one superficial, the other more intimately blended with these minute ramifications of the arteries; but in the internal parts of the body, and particularly the viscera, the veins uniformly accompany the ramifications of the arteries, and in the solid viscera, a dense cellular membrane gives promiscuous lodgement to both sets of vessels.

In the extremities and head, indeed every where but in the viscera, the veins form two distinct sets; the deep and the superficial veins: the deep veins accompanying the arteries; and the subcutaneous veins, which emerge from the compression of the muscles, and run above the fascia. The union betwixt the branches of the veins, is very frequent, not only betwixt the veins, ramifying in the same plane in so much as to make them a mere network; but also betwixt the deep and the superficial set of veins: such are the venæ emissariæ of the scull; the free communications betwixt the external and internal jugular vein, betwixt the deep and superficial veins of the arm, &c. When in bleeding, the blood flows from the vein of the arm, accelerated by the working of the muscles, the blood escapes by the anastomosis, from the compression of the muscles, and fills the superficial veins; but the increase of the jet of blood, is more the effect of the swelling of the muscles, causing the fascia to compress the veins of the fore arm.

In the dead body the veins are flat, but when distended, they resume the cylindrical figure which they possessed in the living body: yet they are in general of the cylindrical figure, for a very little way only, owing to the irregular dilatations by the side of the valves, or by the frequent union of their branches. The manner in which the branches join the trunk, has a peculi-

arity which always distinguishes it from the ramifications of arteries; the arteries branch off at a direct and acute angle, the veins in a direction more removed from the course of the trunk, and in general with a curve or shoulder.

In infancy and youth, the veins are little turgid, and especially the cutaneous veins, are so firmly embraced by the elastic skin and cellular membrane, that they have a less degree of prominency than in more advanced years. In old age, the veins are enlarged, and rise turgid on the surface, and the internal veins also become enlarged and varicose. I do not consider this change in the vascular system, as the effect of mere distention, or of the enlargement of the veins from the long-continued action of the arteries; but as a necessary change in the proportionate distribution of the blood, which is preceded or accompanied with other peculiarities, the character of old age. When we consider the great proportion of the veins in size, over the arteries, we must conclude that the blood flows but slowly in the venous system: that from the narrowness of the trunks of the veins near the heart, the blood must be accelerated, as it approaches the heart, and that receiving the impulse from the ventricle, it must take a rapid course through the arteries, until again approaching the extreme branches of the arteries and passing into the veins, its motion becomes more languid and slow. In youth, as the size of the veins is not in so great a proportion to the arteries, as in advanced life, the blood in a young person, must be in more rapid and quick circulation; but in old age, in proportion to the largeness of the veins and the accumulation of blood in them, the quantity of blood moving slowly through the venous system, and almost stagnant in the dilated veins and sinuses, is very great; it moves but slowly and progressively on towards the centre of the circulation; and upon the whole, the blood in old people, moves less briskly through the vessels, and the proportionate quantity immediately under the influence of the arterial system, is less than in youth.

There is no pulsation to be observed in the veins, but what they receive laterally from the contiguous arteries. There is no pulsation in the veins, because they are removed from the heart; because they do not receive the shock of the heart's action in their trunk, but only by their widely spread branches; because the contraction of the heart, and of the arteries so alternate with each other, in such a manner as to keep up a perpetual and uniform stream of blood into the veins; whereas the pulsation in the arteries is owing to the sudden and interrupted contraction of the heart.

In this general account of the venous system, it remains only

to speak of the subject of absorption. Before the suite of experiments made on this subject by Mr. Hunter, a vague notion was entertained that the veins were absorbents; but about that time,* the doctrine that lymphatics are absorbents having been established, the opinion that the red veins were also absorbents, was first questioned, and finally confuted, at least in the opinion of most physiologists.

The chief argument to show that veins, arising from cavities, particularly from the intestines, acted as absorbents, was, that some anatomists said they had seen white chyle in the blood taken from the mesenteric veins. It was however soon observed that the serum of the blood, taken from the veins of the arm, was sometimes white, which must arise from some other cause than the absorption of chyle.†

The experiments of Mr. John Hunter, proved that there is no absorption of fluid, from aliment contained in the intestinal canal, by the veins of the mesentery, while the lacteals were rapidly absorbing. Emptying a portion of the gut, and the veins of their blood in a living animal, he poured milk into the intestine. The veins remained empty, and without a drop of the milk finding its way into them, while the lacteals became tinged with it. In another experiment, leaving the arteries and veins of the mesentery free and the circulation through them perfect; still no white fluid could be discovered, tinging the stream of blood in the veins. Neither did pressure upon the gut, in any instance force the fluid of the intestines into the veins.—He repeated and varied these experiments, so as to show in a very satisfactory manner, that chyle, or the fluid of the intestines, never is absorbed by the veins.

Yet I must say that these experiments are still unsatisfactory, as they regard the general doctrine of absorption by the veins: in the intestines there is a peculiar set of vessels evidently destined to the absorption of the chyle and of the fluids of the cavity; but there remains a question which will not be easily determined: do not the veins throughout the body resume a part of that substance, or of those qualities, whch are deposited or bestowed by the arteries?—We are assured that in the circulation of the blood through the lungs, and in the extremities of the pulmonic veins, there is an imbibing or absorption: and in the veins of the placenta, there is not only an absorption similar to what takes place in the extreme branches of the pulmonic circulation, but the matter and substance which goes to the nourishment of the fœtus, is imbibed from the ma-

* 1758.
† See Hewson's Exper. Essays and Lymphatic System.

ternal circulation.* So by the vessels in the membrane of the chick in ovo, there is absorbed that which being carried to the chick, bestows nourishment and encrease. For my own part, I cannot but suppose that, while the lymphatics absorb the loose fluids which have been thrown out on surfaces, or into cavities—the veins receive part of what is deposited from the arteries ; but, which is not so perfectly separated from the influence of the circulating system, as that which the lymphatics receive ; and that there are certain less palpable, and perhaps gaseous fluids, which they imbibe in the course of the circulation by an affinity of the venous blood, similar to the attraction which takes place in the lungs. We must at the same time acknowledge, that the conclusions made in favour of absorption by veins, from experiments upon the dead body, are fallacious, and have no weight.—It is seldom we can determine whether minute injections have taken a course by a natural, or by a forced passage : neither are the experiments of some of the older physiologists more satisfactory or conclusive. Lower affirmed that, by throwing a ligature on the inferior cava of a dog, he produced ascites. He tied the jugular veins of a dog, and the head became dropsical. Hewson repeated these experiments, but without the same result. And if the tying of the veins had always produced œdema or dropsy, the experiment would have proved nothing more than is already established by the very common occurrence of œdema of the legs, from the pressure of the womb on the iliac veins, or a tumor in the groin, or in the pelvis. Now in these instances the compression of the vein does nothing more than cause a difficult circulation of the blood, from the extreme arteries into the veins, and consequently a greater profusion of the discharge into the cellular texture by the serous arteries.

OF THE VEINS, BRANCHES OF THE SUPERIOR VENA CAVA.

The superior vena cava, or the descending cava, is the superior trunk of the venous system ; which receives the veins of the head, neck, and arms, and throws the blood directly into the great right sinus, or auricle of the heart.

* Dr. Hunter, Hewſon, &c. ſay that it is probable there are many ſmall lymphatics in the placenta, which open into the branches of the veins, and do not take a courſe along the chord. This is very improbable, and has no ſupport from analogy.

SECTION I.

OF THE VEINS OF THE HEAD AND NECK.

THE ANTERIOR FACIAL VEIN.*. The facial, or anterior facial vein, runs down obliquely from the inner canthus of the eye, towards the angle of the lower jaw-bone. Here uniting with the temporal vein, it forms the external jugular vein. The most remarkable branches of veins which assist in forming the facial vein, are the FRONTAL VEINS; which receive the blood from the forehead and frontal portion of the occipito-frontalis muscle, and the OPHTHALMIC VEIN, which is one of the emissariæ, and comes from the cavernous sinus through the orbit.—In its course down the cheek, the facial vein receives the several cutaneous branches of veins, from the surrounding parts: but which have in reality no such importance as to require description.†

THE POSTERIOR FACIAL VEIN; OR, GREAT TEMPORAL VEIN.—This vein descends from the temple before the ear, through, or under the mass of the parotid gland, and behind the angle of the lower jaw.

This posterior vein receives those branches which are the proper temporal veins, and which are four in number, and descend upon the side of the head ‡; and those which answer to the submaxillary artery, and also the vena transversa faciei, and the auricular veins. Finally into some of the deep branches of this vein§ the blood enters from the veins accompanying the arteria meningea. The posterior facial vein, uniting with the anterior one, forms a common trunk, which in general lies over the division of the carotid artery.

EXTERNAL JUGULAR VEINS.

THE external jugular vein takes a course obliquely down the neck, and across the middle of the mastoid muscle. It lies under the fibres of the platysma myoides muscle, and drops either into the subclavian vein, or into the internal jugular vein. Sometimes there are two external jugular veins on each side; more commonly there are two branches high in the neck, from the anterior and posterior facial veins, which unite

* *Facial vein; V. Angularis; V. Triangularis.*

† *Vena dorſalis naſi, ſuperior et inferior—Vena palpebralis inferior externa et interna—Vena alaris naſi—Venæ labia es magnæ et minores, &c. Venæ buccales, &c.*

‡ Being in two ſets the deep, and ſuperficial.

§ *Viz. Venæ Pterygoideæ.*

about the middle of it. When they are double they have this course; the *anterior and external* jugular vein, may be said to begin from the anterior facial vein; it then receives the submental vein, which comes in under the base of the lower jaw—the ranine veins also, and veins from the glands under the jaw join it here: where it is before the mastoid muscle, it forms free communications with the internal jugular veins; and here also, it receives veins from the side of the throat.*

Almost all the ramifications of veins, which in one subject unite to the external jugular vein, and which come from the face and throat, do in others sink down into the internal jugular vein.

Sometimes the anterior and external jugular veins join the internal jugular vein; sometimes the subclavian vein.

The posterior external jugular vein is formed chiefly by the temporal vein, or, posterior facial vein, which comes down from under the parotid gland; it is then joined by the occipital veins†, a little lower by the cervical veins, and lastly on the lower part of the neck it receives the muscular branches from the flesh of the shoulder; it then sinks into the subclavian veins.

Of the thyroid veins.—The thyroid gland has two sets of veins, as it has of arteries; the *superior thyroid* veins carry back the blood from the muscles of the fore part of the throat, from the larynx, from the substance of the thyroid gland, and from the neighbouring part of the trachea and pharynx, and even from the fauces. Sometimes these thyroid veins enter the external jugular vein; sometimes they descend upon the neck, taking the name of guttural veins; they unite themselves with the internal jugular vein.

The lower thyroid veins.—Come from the lower part of the thyroid gland, and descend upon the fore part of the trachea, and enter the subclavian; or, more generally, the great, or internal jugular veins.

Of the internal jugular vein.—The internal jugular vein is formed by the conflux of the several great and posterior sinuses of the dura mater into the lateral sinus, which coming out by the foramen lacerum posterius of the basis cranii, ceases to be constricted into the triangular shape, and takes the form and peculiarities of a vein. From this foramen, common to the temporal and occipital bone, the jugular vein descends obliquely forward and downward, becoming from its deep situa-

* Viz. The ſuperior thyroid veins, and the deep laryngeal veins.

† Theſe communicate with the vertebral veins, and through the poſterior maſtoid foramen with the lateral ſinus.

tion somewhat more superficial, but in all its extent protected by the sterno-cleido-mastoideus muscle; and it passes under the omo-hyoideus muscle. The internal jugular vein is very irregular in its form; being sometimes much contracted under the angle of the jaw; bulging and much enlarged, or rather capable of being much distended in the middle of the neck; and again contracted before it joins the subclavians. The carotid artery, the internal jugular vein, and the par vagum lie together in the same sheath of loose cellular membrane.

The internal jugular vein receives these communications and branches; behind the angle of the lower jaw, a branch of communication, generally goes down from the posterior facial vein, and often it is joined by the internal maxillary vein: under the jaw, it either forms free communications with the beginning of the external jugular vein, or it receives the ranine and guttural veins; at all events, there is a branch from the side of the throat, and the muscles of the os hyoides which passes into the internal jugular vein. From under the back part of the mastoideus muscle, it receives branches from the occipital veins, and forms communications with the vertebral veins: near its termination the great jugular vein receives the guttural and lower thyroid veins.

Of the vertebral veins.—There is difficulty in assigning origins to these veins, for they are rather like a chain of communication; they run in the holes of the transverse apophysis of the cervical vertebræ, and surround the processes with areolæ. First a communication is formed with the great lateral sinus, then they receive the flat sinuses from under the dura mater, covering the cuneiform process of the occipital bone, (the basilar sinuses) and as they descend they form transverse communications, which receive the branches of that chain of inosculations, which runs down upon the spinal marrow. The vertebral veins, in their descent, send out divisions which run down upon the outside of the canal, and receive branches of veins from the muscles on the fore part of the vertebræ, and some of the proper cervical veins from behind. The *vena cervicalis* coming from the side of the neck, unites with the vertebral vein near its termination, in the back part of the subclavian, or sometimes in the axillary vein.

SECTION II.

OF THE VEINS OF THE ARM.

THE veins of the arm are in two sets, the venæ comites; and the external or subcutaneous veins, being those without the fascia, and not subject to the compression of the muscles. Of these, the latter are the more important and require a particular description.

On the palm of the hand, the veins are few and small, because they are there subject to compression in the frequent grasping of the hand; but on the back of the hands and fingers, the veins are numerous and large. The veins creeping along the fingers, make a remarkable inosculation on the back of the first phalanges, and then passing in the interstices of the knuckles, form a great and irregular plexus on the back of the hand*: the principal branch of which sometimes takes the form of an arch†.

The plexus of veins from the back of the hand is continued over the back of the wrist: when some of the larger branches, after playing over the heads of the radius and ulna, take a course, the one on the lower, and the other over the upper edge of the arm, whilst the back of the arm is left without any remarkable veins taking their course there.

The veins on the back of the hand have nerves intermingling with them, viz. branches of the ulnar nerve, and the extreme branches of the muscular spiral nerve: so that it is a great mistake to suppose that bleeding in the back of the hand might be substituted with advantage for the common operation in the bend of the arm.

VENA CEPHALICA.—The vein of the back of the thumb running into a trunk, which takes a course over the outside of the wrist, is called CEPHALICA POLLICIS.

From this vein and the division of the plexus of the back of the hand, a considerable trunk is generally formed, which takes its course on the radial edge of the arm, and is called CEPHALICA MINOR, or RADIALIS EXTERNA. This vein in its tract over the extensor radialis, and the supinator longus, has many lateral communications, particularly with the median vein.

This vein, now joined by the median cephalic, and rising upon the outside of the humerus, is the great cephalic vein; and it passes, first betwixt the biceps and triceps brachii, and

* *Plexus dorsalis manus.* † *Arcus venosus dorsalis.*

then betwixt the deltoides and pectoralis major muscles. Several small cutaneous veins play over the belly of the biceps muscle, and communicate with the basilic vein; a little below the external condyle of the os humeri, the cephalic vein detaches a branch which ascends betwixt the brachialis internus and supinator longus, and which afterwards forms inosculations with the basilic vein, on the back of the arm.

The great cephalic vein passing up betwixt the tendons of the pectoralis major and the deltoid muscles, sinks into the axilla and joins the axillary vein. The LESSER CEPHALIC is a vein which runs up betwixt the pectoral and deltoid muscles, and sinks generally into the subclavian vein: sometimes it joins the external jugular vein.

VENA BASILICA*. We trace the origin of the basilic vein from those veins which, being continued from the plexus, on the back of the hand, take their course over the lower head of the ulna. (A conspicuous branch of these veins, from the little finger, was called *salvatella* by the ancients). From this origin, the basilic vein takes a spiral course on the ulnar edge of the fore arm, sometimes in one great trunk, oftener in two, sometimes in a plexus of veins; here it may be called ULNARIS SUPERFICIALIS, or CUBITALIS INTERNA. This vein, now rising before the inner condyle of the humerus, passes on the inner margin of the biceps flexor muscle; here it forms very free and numerous connections with the internal or brachial vein; the satellites and cephalica, now passing up, until it sinks under the tendon of the pectoral muscle, it joins the axillary vein.

The great basilic vein, or the great trunk, after it has ascended above the elbow, and received the median basilic, is joined by several deep branches of veins, as those which accompany the brachial artery, called satellites or comites, a vein which is called profunda brachii; and still nearer its determination, it receives the addition of the *vena subhumeralis* or *articularis*, and the *venæ scapulares*, viz. those answering to the arteries of that name.

VENA MEDIANA MAJOR†.—This is a vein which runs up the middle of the fore arm, beginning from the plexus of veins, which play over the flexor tendons, and come from the ball of the thumb; it is a vein which is very irregular, being sometimes double, and sometimes rather in the form of a plexus,

* Brachialis. The ancients termed the basilic vein of the right arm, the vein of the liver, or vena hepatica brachii, and that of the left, the vena splenica brachii.

† *Vena Media, vena superficialis communis.*

than to be considered as a regular trunk ; often it is particularly short, and can be considered as a trunk, only for a few inches as it approaches the bend of the arm ; not unfrequently it is entirely wanting, and as if annihilated by the preponderance of the branches of the cephalic or basilic vein. But to take the more common course, as an example, when it has ascended on the middle of the fore arm, near to the bend of the arm it divides ; one branch passes obliquely outward, and joins the cephalic vein, the other inwards and unites with the basilic vein ; the first, is of course the MEDIAN CEPHALIC VEIN, the second, the MEDIAN BASILIC VEIN.

These are the two branches which the surgeon most commonly selects for bleeding. Around the median cephalic, the cutaneous nerves play more profusely, and under the median basilic vein the humeral artery passes. It is by the aukward plunging of the lancet into the median basilic, that the country bleeder so frequently produces the aneurism of the artery ; but the dreadful symptoms following the pricking of the nerve, are more frequently produced by bleeding in the median cephalic ; cases however occur of the pricking of the nerves, while bleeding in the median basilic vein.

AXILLARY VEIN.—The trunk of the veins of the arm passes through the axilla, until it arrives betwixt the first rib and clavicle, under the name of axillaris. Here lying by the side of the artery, it receives many muscular branches from the flesh of the shoulder, the external and internal scapular veins, and the thoracic veins ; in general where it passes by the head of the humerus it receives the cephalic vein.

SUBCLAVIAN VEINS.—The axillary vein continuing its progress over the first rib, becomes the subclavian vein : on the right side the vein is shorter, and descends more obliquely ; on the left it is longer, of course less oblique, but still its direction is downward ; passing before the trachea, and the branches of the arch of the aorta, it joins the subclavian of the right side, and together they form the superior cava : the subclavian vein receives these veins, a vein from the shoulder and lower part of the neck, the vertebral vein, with some lesser plexus of veins descending from the neck, the internal jugular vein (and in the angle of the union of these the thoracic duct), and lastly the thyroid veins. From below they receive the lesser internal thoracic veins.

SECTION III.

THE SUPERIOR VENA CAVA, THE VENA AZYGOS, AND LESSER VEINS OF THE THORAX.

THE superior vena cava is the trunk of all the veins of the head, neck, arms, and of the parts in the thorax; soon after it is formed by the subclavian veins, it is joined by the vena azygos, and receiving the INTERNAL MAMMARY VEINS and the VENÆ THYMICÆ and PERICARDIAC branches, the INTERCOSTAL and BRONCHIAL veins, it descends into the pericardium, and dilates or opens into the right sinus or auricle.

VENA AZYGOS.* This is the principal vein of the thorax, and chiefly of the walls of the thorax. It is observed to take its origin upon the vertebræ of the loins from some of the lumbar veins, or by inosculations with the renal spermatic or lesser branches of the abdominal cava, receiving the first and second lumbar veins, as in its ascent in the thorax, it receives the intercostal veins on either side†; ascending betwixt the crura of the diaphragm, and by the side of the aorta, it sometimes receives the lower phrenic veins; in the thorax lying on the right side of the bodies of the vertebræ, and before intercostal arteries, it receives the bronchial veins from the root of the lungs, and from the trachea it receives the veins of the posterior mediastinum and œsophagus; through the intercostal veins, it communicates with the external and internal mammary veins, and with the venal circles of the spinal marrow.

Upon the third vertebra, the azygos vein separates from the spine, and with an arch, and bending round the root of the lungs, it opens into the superior cava, just where it is about to enter the pericardium: where it opens into the great vein, it is guarded by a valve.

This vein however, like most others, has considerable variety, and does not always merit the name of azygos, for sometimes it is double, a division ascending on the left side of the spine, and uniting with the branch of the other side, just as it is about to enter into the superior cava.

OF THE LESSER VEINS IN THE THORAX.—The VENÆ MAMMARIÆ take a course by the side of the internal mammary artery, and require no description. Like the arteries, they spread their branches on the muscles of the belly, and communicate

* Sine pari.

† We except ſome of the veins from the interſtices of the higher ribs, particularly on the right ſide, which enter the ſubclavian vein.

with the diaphragmatic and lumbar and epigastric veins. The left mammary vein terminates in the left subclavian vein, the right in the superior vena cava.

THE VENÆ THYMICÆ enter, either into the union of the subclavian veins, or they enter into the guttural veins, or the internal mammary veins.

THE PERICARDIAC VEINS gather their branches from the pericardium, from the aorta, trachea and lymphatic glands; they send down branches by the side of the phrenic nerve, which inosculate with the veins of the diaphragm; they enter the internal mammary vein, or the superior cava, or the termination of the right subclavian.

THE SUPERIOR INTERCOSTAL VEINS.—The right and left intercostal veins differ in their size and distribution; the right is small, and receives only one or two of the upper intercostal veins, which do not enter into the azygos vein. The vein of the left side begins even so low as the interstice of the seventh rib; it receives branches from the pleura, pericardium and lungs (viz. the bronchial veins) and from the œsophagus; they enter the subclavian veins.

CHAP. II.

OF THE VEINS WHICH UNITE TO FORM THE INFERIOR VENA CAVA.

THE inferior vena cava receives the veins of the lower extremities, the hypogastric and abdominal veins, and the veins of the viscera of the abdomen; but those of the membraneous contents of the abdomen are received by it only indirectly, and through the circulation of the liver.

OF THE VEINS OF THE LEG AND THIGH.

WE have observed that the veins of the extremities are in two sets; the deep and superficial. In the leg and thigh the deep-seated veins accompany the arteries, and receive the same name: the cutaneous veins are the saphena major and minor.

SAPHENA MAJOR*.—A large and beautiful plexus of veins is formed on the fore part of the foot, and coming from the back of the toes, and outside of the foot. Two principal veins arise from the arch which these form: one takes the course behind the inner ankle, and is the saphena major; the other passes over the outer ankle, and forms the saphena minor.

The great saphena may be traced from the great toe, from the inside of the foot, and behind the ankle: it receives one or two branches from the sole of the foot. Sometimes the principal branch passes behind the lower head of the tibia, sometimes before it, or it forms circles here: a little above the ankle a vein from the middle of the metatarsal arch comes obliquely over the tendon of the tibialis anticus and joins it.

The saphena, now a considerable trunk, runs up the leg before the inner margin of the belly of the gastrocnemius muscle, and on the inner ridge of the tibia. In this course it receives numerous cutaneous branches, and backward, over the belly of the muscles, it forms inosculations with the lesser saphena. From the inside of the leg the trunk ascends on the inside of the knee, where it receives several branches, coming round the

* *Saphena magna, interna.*

joint, and over the tibia. Now passing somewhat obliquely, it ascends upon the thigh, and, at the same time, turns from the inside to the fore part of the thigh. In the thigh the great saphena receives many branches, and is not always a single vein: for sometimes the branches collecting form a small trunk, running collateral to the greater vein, and which joins it in the groin. In all this course the saphena vein is superficial, and lies imbedded in the cutaneous fat; with but a very slight and imperfect aponeurosis inclosing it; while it is external to the proper fascia of the leg and thigh. As it ascends upon the thigh, however, it does not dive suddenly under the fascia; but is gradually enveloped and embraced by the condensed cellular membrane and fascia.

When it was more the practice than at present to bleed in the ankle, the saphena major was the vein selected: but as in all the course of the vein, from the great toe to the knee, it is connected with the nerve which bears its name, there are not wanting instances of those bad effects from pricking of the nerve, which not unfrequently follow the bleeding in the arm.

SAPHENA MINOR*. This vein arises from the plexus on the outside of the dorsum pedis: it runs over the outer ankle and above the fascia, covering the tendons of the peronei muscles. Here receiving many branches, and forming frequent deep inosculations, it mounts on the outside of the vagina or fascia, which covers the back of the leg, until arriving betwixt the hamstring tendons it sinks into the popliteal hollow, terminating in the popliteal vein.

The other veins of the lower extremity which accompany the arteries in their course, need little description.

ANTERIOR TIBIAL VEIN.—The veins accompanying the anterior tibial artery form many inosculations, and when minutely injected, almost conceal the artery. They are the anterior tibial veins and only unite into a trunk, where perforating the interosseous ligament it joins the popliteal vein.

POSTERIOR TIBIAL VEIN.—In the sole of the foot we have the external and internal plantar veins, which uniting into trunks, accompany the artery behind the inner ankle. In its course betwixt the soleus and the tibialus anticus muscles, it cannot be called the posterior tibial vein; for it is a mere network of veins surrounding the posterior tibial artery. It receives, near its termination, a branch called SURALIS, from the gastrocnemii and soleus: it terminates in the popliteal vein.

THE VENÆ PERONEÆ are the venæ comites by the tibial artery, and are two or three in number. All these veins have free inosculations with each other.

* *Vena ſaphena parva, externa.*

THE POPLITEAL VEIN.—This vein is formed by the three divisions of deep veins accompanying the arteries of the leg, and the saphena minor. It lies more superficial than the artery, and seems to cling round it. As it ascends, however, it twists round the artery, the artery being nearest the bone—a little above the joint it receives the lesser saphena.

This vein, perforating the tendon of the triceps, comes to the fore part of the thigh, still united to the artery: it is now the CRURAL VEIN. As it ascends it gets from behind the artery, so that in the groin it lies nearer the pubes than the artery does: opposite the trochanter minor it receives the internal and external circumflex veins, and the PROFUNDA FEMORIS. About an inch below Poupart's ligament the crural vein receives the saphena major, and the small external pudic veins.

EXTERNAL ILIAC VEIN.—The femoral vein lying on the inside of the artery or nearer the pubes, enters the abdomen under the femoral ligament, and passing by the side of the Psoas muscle becomes the external iliac vein. It receives several lesser veins just within the ligament particularly the epigastric vein from the muscles and integuments of the belly, and the veins accompanying the arteria circumflexa ilii. The external iliac vein is joined by the HYPOGASTRIC VEIN which ascends from the pelvis. It requires no minute description; it answers to the distribution of the hypogastric artery. This which is the internal iliac joining the trunk from the thigh forms the COMMON ILIAC VEIN.

VENA CAVA ABDOMINALIS.*—A little lower than the bifurcation of the aorta, the right and left common iliac veins unite. By this union they form the vena cava. This vein ascends upon the right of the aorta. It receives fewer branches than would naturally be imagined, because the veins of the viscera take their course by the porta into the liver. It receives the lumbar veins, the spermatic veins, the renal, superrenal, and phrenic veins. Passing upward it is received into its appropriate fossa in the liver, and seceding a little from the spine it receives the VENÆ CAVÆ HEPATICÆ and perforates the diaphragm; entering the pericardium it expands into the great sinus, or right auricle of the heart.

RENAL VEINS†.—These veins are less irregular than the arteries of the kidney, which relation of the veins and arteries is uncommon. From the relative situation of the kidneys to the cava it is evident that the right vein must be short; the left comparatively longer and taking a course from the kidney over the aorta.‡

* *Vena Cava inferior.* † Emulgent veins.

‡ The Renal veins however sometimes vary in their number, the right being double or triple, the left even sometimes in four branches.

Supra-renal veins.—These little veins are like the arteries in their course. The right one enters sometimes into the vena cava, sometimes into the renal vein. The left sometimes receives the phrenic vein of that side and enters into the renal vein.

Spermatic veins.—Of the general distribution of these veins nothing need be said, after looking to the description of the arteries.*

The Vena Portæ has been already described in the second volume.

* See page 117.

OF THE TEETH.

THERE is naturally an inclination in the author of a system to amplify some particular subjects, and to abridge, or bestow less attention, on others which may to him appear less interesting or curious. To restrain this tendency has been the most irksome task which I have felt in completing the present work. The growth and structure of the teeth forms an elegant and interesting subject of enquiry; and it is difficult to concentrate the view of it so as to be consistent with the arrangement of a systematic work.

As the general nature and use of the teeth are sufficiently understood, there can be little objection to our beginning the present subject with considering the structure of the human teeth.

OF THE STRUCTURE OF THE TEETH.

A tooth consists of these parts.—In the first place, the ENAMEL, a peculiarly hard layer of matter composing the surface of the body of the tooth. The internal part, body, or substance of the tooth, is less stony and hard than the enamel, but of a firmer structure and more compact than common bone. In regard to the form of the tooth, we may observe that it is divided into the crown, neck, and fangs, or roots of the tooth, which go deep into the jaw. There is a cavity in the body of the tooth, and the tube of the fangs communicates with it. This cavity receives vessels for supplying the remains of that substance upon which the tooth was originally formed. The roots of the teeth are received into the jaw by that kind of articulation which was called gomphosis. They are not firmly wedged into the bone, for, in consequence of maceration, and the destruction of the soft parts, the teeth drop from the scull. There is betwixt the tooth and its socket in the jaw a common periosteum.

OF THE ENAMEL. The surface of a tooth, that which appears above the gum, is covered with a very dense hard layer of matter, which has been called the enamel. In this term there is some degree of impropriety, as assimilating an animal

production with a vitreous substance, although the enamel very widely differs from the glassy fracture when broken. This matter bestows the most essential quality of hardness on the teeth; but it is probably useful in another way, being intermediate betwixt the central bony part of the tooth, which has life, and is subject to disease, and matter altogether foreign to the living body. When the enamel is broken off, and the body of the tooth exposed, it quickly decays.

The enamel is the hardest production of the animal body. It strikes fire with steel: in church-yard sculls it is observed to resist decay when the centre of the tooth has fallen into dust. It has been found that the component parts of the enamel are nearly the same with those of bone: in bone the phosphate of lime is deposited on the membranes, or cartilage, but this hardening matter of bones is a secretion from the vessels of the part, and is accumulated around the vessels themselves: it is still within the controul of their action, and is suffering the succession of changes peculiar to a living part. But, in the enamel, the phosphate of lime has been deposited in union with a portion of animal gluten, and has no vascularity, nor does it suffer any change from the influence of the living system. Although the hardening matter be principally phosphate of lime, a small proportion of the carbonate of lime enters into the composition both of bone and of enamel.

Although we call the earthy deposit the hardening matter, yet it is the union of the glutinous matter which bestows the extreme hardness, for, when the tooth is as yet within the jaw, and in an early stage of its formation, the deposition is soft, and its surface rough; but, by a change in the surface, which throws out this secretion, the first deposition is penetrated with gelatinous secretion, which, either by this penetration simply, or by causing a new apposition of its parts, (its structure indeed looks like crystallization,) bestows the density and extreme hardness on this crust. When an animal is fed with madder, the colouring matter coming, in the course of the circulation, in contact with the earth of bone, is attracted by it, and is deposited upon it in a beautiful red colour. This colouring matter penetrates more than injection can be made to do in the dead body; and, as by this process of feeding, the enamel is not tinged, we have a convincing proof that the vascular system has no operation on the enamel after it is formed.

From the composition of the enamel, we must be aware of the baneful effects of acidulated washes and powders to the teeth: they dissolve the surface, and give a deceitful whiteness

to the teeth; they erode the surface, which it is not in the constitution of the part to restore.

Of the central bony part of the tooth. The chemical composition, and the manner of combination of the matter forming the central part of the tooth, and of the fangs, is similar to the other bones of the body; but when we examine the hardness and the density of the tooth, and see that it is not even porous, or apparently capable of giving passage to vessels, we doubt of its vascularity, and are apt to suppose that it holds its connection with the living jaw-bone by some other tenor than that of vessels, and the circulation of the blood through it. I must acknowledge that the difficulty in deciding on the vascularity, and degree of vitality which the teeth possess, appears to me so great, that I shall at present venture to give no decided opinion. The vascularity of the periosteum, which surrounds the teeth and vessels which enter by the fangs to the cavity of the teeth, seemed to shew a sedulous care to supply the tooth plentifully with blood. As this part of the tooth has often been coloured by feeding young animals with madder, the reverse of that experiment, which convinces us there is no circulation in the enamel, should satisfy us that there is blood circulating through the body of the tooth, and that it undergoes the same changes by absorption which the other bones are proved to do; but these experiments may have been made while the teeth were forming by the deposition from the pulp, and of course they might be coloured without the experiment affording a fair proof that the circulation continues in the tooth after it is formed. If it be proved that the adult teeth, or a fully formed tooth yet within the jaw, are uniformly tinged with the madder, we must without reserve conclude, that the economy of the teeth is in all respects like that of the common bones.

The teeth undergo changes of colour in the living body, to which it would appear they could not be liable as dead matter. They become yellow, transparent, and brittle with old age; and when a tooth has been knocked from its socket, and replaced, dentists have observed that it loses its whiteness, and assumes a darker hue.

The absorption of the roots in consequence of the caries of the body of the tooth, and the absorption of the fangs of the deciduous teeth, are further alleged in proof of their vascularity; not only the pressure of the rising tooth on the fangs of the temporary teeth will cause an absorption of the latter, but the fangs of the temporary teeth will waste and be absorbed, so as to drop out without the mechanical pressure of the per-

manent teeth, and before they have advanced to be in contact with the former.

The teeth seem acutely sensible, but a little consideration teaches us that the hard substance of the teeth is not endowed with sensibility, and that it must be the remains of the vascular pulp, presently to be described, occupying the centre of the tooth, which being supplied with nerves, gives the acute pain in tooth-ach. It is as a medium communicating or abstracting heat, that the tooth itself seems to give pain. When wrought upon by the dentist, no sensation is produced unless the tremor be communicated to the jaw, or unless the abrading, or cutting instruments, be so plied as to heat the tooth ; then an acute pain is produced from the heat communicated to the centre ; and so, extremely cold substances, or liquids, taken into the mouth, still produce pain, from the cold affecting the pulp of the tooth.

As living parts, the teeth have adhesion to the periosteum, and are connected with their internal pulp ; but when they spoil, and are eroded, the disease spreads inwardly, probably destroying the life of the bony part of the tooth, the progress of which disease is marked by a change of colour penetrating beyond the caries towards the centre of the tooth. When this discolouration has reached the internal surface, the pain of tooth-ach is excited, the pulp, vascular and supplied with nerves, inflames, from a want of accordance with the altered state of the tooth, just as the dead surface of a bone will inflame the central periosteum and marrow. The extreme pain produced by this state of the tooth probably proceeds from the delicate and sensible pulp swelling in the confinement of the cavity of the tooth.

In caries of the teeth, the body of the tooth is discovered deep in its substance long before the pulp of the central cavity is exposed by the progress of the caries. No exfoliation, or exostosis, takes place upon that part of the tooth which is above the gum, which may be owing to the mere compactness of the ossific depositions, for we know that the bones of greatest density are the most apt to yield altogether to diseased action, and die, instead of throwing off their surface, in exfoliations, or taking any other variety of diseased action.

In the further consideration of this subject, there are circumstances which will make us doubt of there being vascular action in the teeth, and perhaps incline us to believe that they possess a lower degree of life, and are less subject to change than other parts. Supposing the bony part of the tooth to be vascular, and to possess the principle of life, is not the firm adhesion and contact of the enamel to the body of the tooth a

curious instance of a part destitute of life adhering to the surface of a living part, without producing the common effects of excitement and exfoliation, or inflammation, in the latter? Is the enamel, though not a vascular part, possessed of some quality which distinguishes it from foreign matter, or is the bony part of the tooth possessed of so low a degree of vascular action, that it is not excited by the contact and adherence of the enamel? We must suppose that some accordance subsists between them from what is observed to be the effect of the loss of the enamel, for then the bone of the tooth spoils rapidly, and becomes carious.

In rickets, and molities ossium, and other diseases of debility in which the body wastes, or the growth is retarded, the growth of the teeth is not retarded in the one case, nor are the grown teeth altered in their form or properties in the other. This appears to me to support the idea of there being a distinction in the economy between the manner of the formation of the teeth, and of common bone. The effects which we perceive in the bony system under these diseases, are produced by a preponderance of the absorbents over the activity of the secreting vessels; while in the teeth no such effect can take place if they are formed by a deposition of bony matter which is not re-absorbed, nor undergoes the revolution of deposition and re-absorption, as in other parts of the body is the case. Accordingly we find in rickets, and the molities ossium, where the hardest bone yields, where the jaw-bone itself is distorted or altered in its form, that the teeth remain distinguished for their size and beauty; and in rickets the teeth are large, and perfectly formed, while the jaws are stinted and interrupted in their growth. The consequence of this is, that the teeth form a larger range than the jaw, and give a characteristic protuberance to the mouth.

The roots of the teeth are sometimes found enlarged, distorted, or with exostosis formed upon them. Again the cavity of the tooth is found to have been filled up with the formation of new matter, or around the fangs we often find a small sac of pus, which is sometimes drawn out in extracting the tooth. Nevertheless, in these examples of disease, there are no unequivocal marks of vascular action in the teeth; the unusual form, or exostosis of the roots, is produced by an original defect in the formation. The filling up of the cavity of the tooth is caused by the resumed ossific action of the pulp in consequence of the disease and destruction of the body of the tooth; and the abscesses which surround the fangs are caused by the death of the tooth, in consequence of which it has lost

its sympathy with the surrounding living parts, and becomes a source of irritation like any other foreign body.

We must conclude, that the whole phenomena displayed in the formation, adhesion, and diseases of the teeth, show them to be possessed of life, and that they have a correspondence, or sympathy with the surrounding parts. But are we prepared to acquiesce in the opinion of Mr. Hunter, that they possess vitality while yet they have no vascular action within them? We naturally say, how can such vitality exist independently of a circulation? But there are not wanting examples of an obscure and low degree of life existing in animals' ova, or seeds, for seasons without a circulation; and if for seasons, why not for a term of life? We never observe the animal economy providing superfluously, and since there is no instance to be observed in which the teeth have shown a power of renovation, why should they be possessed of vascularity and action to no useful end? All that seems necessary to them is, that they should firmly adhere without acting as a foreign and extraneous body to the surrounding parts, and this, vitality without vascular action, seems calculated to provide.

OF THE FORMATION AND GROWTH OF THE TEETH.

In the jaws of a child newly born, there are contained two set of teeth as it were in embryo: the deciduous, temporary, or milk teeth; and the permanent teeth. The necessity for this double set of teeth evidently is to be found in the incapacity of alteration of shape or size in the teeth as in other parts of the body; the smaller teeth, which rise first, and are adapted to the curve and size of the jaw-bone of an infant, require to be succeeded by others, larger, stronger, and carrying their roots deeper in the jaw.

Each tooth is formed in a little sac, which lies betwixt the plates of bone that form the jaw-bone of the fœtus, or child, under the vascular gum, and connected with it.

When we open one of these sacs at an early period of the formation of the tooth, a very curious appearance presents itself: a little shell of bone is seen within the sac, but no enamel is yet formed. Upon raising the shell of bone, which is of the shape of the tooth, and is the outer layer of the bony substance of the tooth, a soft vascular stool, or pulp*, is found to have been the mould on which this outer layer of ossific matter has been formed; and a further observation will lead us to conclude that this bony and central part of the tooth is in the

* Le noyau, la coque, or le germe de la dent, by the French authors.

progress of being formed by successive layers of matter thrown out from the surface of this vascular pulp; though many have explained the formation of the tooth, by supposing that the layers of this pulp were successively ossified.

If we now turn our attention to the state of those teeth which we know to be later of rising above the gum, we shall find the ossification still less advanced, and a mere point, or perhaps several points of the deposited matter on the top of the pulp.

The pulp, or vascular papilla on which the tooth is formed, has not only this peculiar property of ossification, but, as the period of revolution advances, where it forms the rudiments of the molares for example, its base splits so as to form the mould of two, three, or four fangs, or roots; for around these divisions of the pulp the ossific matter is thrown out so as to form a tube continued downward from the body of the tooth. Gradually, and by successive layers of matter on the inside of this tube, it becomes a strong root or fang, and the bony matter has so encroached on the cavity, that only a small canal remains, and the appearance of the pulp is quite altered, having shrunk in this narrow space.

We have said that the tooth forming on its pulp, or vascular bed, is surrounded with a membrane giving the whole the appearance of a little sac. This membrane has also an important use. It is vascular also as the pulp is, but it is more connected with the gums, and receives its vessels from the surface, while the pulp, lying under the shell of the tooth, receives its blood-vessels from that branch of the internal maxillary artery which takes its course in the jaw.

The enamel is formed after the body of the tooth has considerably advanced towards its perfect form. It is formed by a secretion from the capsule, or membrane which invests the teeth,* and which is originally continuous with the pulp. The enamel is thicker at the point, and on the body of the tooth, than at its neck. Mr. Hunter supposed that the capsule always secreting, and the upper part of the tooth being formed first, it would follow of course that the point and body of the tooth would be covered with a thicker deposition; but it rather appears that the part of the sac opposite to the upper part, and body of the tooth, has a greater power of secreting, being in truth more vascular and spongy, for the whole of the body of the bony part of the tooth is formed before the enamel invests the tooth.

We are indebted to M. Herissant for much of the explana-

* This outer ſac has been called *chorion*, from the numerous veſſels diſtributed upon it. See Heriſſant.

tion of the manner in which the enamel is formed. He describes the sac,* its attachment to the pulp, and to the neck of the teeth,—as the tooth advances to its perfect form, the sac also changes. At first it is delicate and thin, but it thickens apace. And he asserts, that if after this progress is begun you examine the inner surface of it with a glass, you will perceive it to be composed of little vesicles in regular order, and which sometimes have a limpid fluid contained in them. This liquid exuded upon the surface of the teeth he supposes to form the enamel. He explains also how this sac, originally investing the body and neck of the tooth, being pierced by the edge of the tooth, and the tooth rising through it, is inverted, and by still keeping its connection with the circle of the crown of the tooth, rises up in connection with the gum, and in some degree forms the new gum which surrounds the tooth.

Succeeding authors have found this membrane double. We may examine it most successfully, says Mr. Hunter, in a new-born child, and we find it made up of two lamellæ, an external and an internal; the external is soft and spongy, without any vessels; the other is much firmer, and extremely vascular, its vessels coming from those that are going to the pulp of the tooth. He adds, that while the tooth is within the gum, there is always a mucilaginous fluid like the sinovia in the joints between this membrane and the pulp of the tooth.

OF THE GROWTH OF THE SECOND SET OF TEETH, AND THE SHEDDING OF THE FIRST SET.

The first, or deciduous set of teeth, being adapted only for the jaws of a child, are destined to be shed, and to give place to the adult, or permanent set of teeth. Accordingly, in observing the progress of the formation of the first teeth, the rudiments of the second may also be seen in the fœtus of the seventh or eighth month: and in the fifth and sixth month after birth, the ossification begins in them. The rudiments of the permanent teeth may be observed even when the sac is very small, and appear like a filament stretching up to the neck of the sac of the deciduous teeth. These sacs lie on the inner side of the jaw-bone, and when further advanced, the necks of the two sacs, (both as yet under the gum) are united; but when the first teeth are fully formed, and have risen above the gum, the alveolar processes have been at the same time formed around them, and now the sac of the permanent teeth have a connec-

† Reſſemble aſſez à une petite bourſe fermée.

tion with the gums through a small foramen in the jaw-bone, behind the space through which the first teeth have shot.

The opinion now entertained, that the second set of teeth pushes out the first, is very erroneous, for the change on the deciduous and the growing teeth seems to be influenced by laws of coincidence indeed, but not of mechanical action. Sometimes we observe the falling tooth wasted at the root, or on the side of the fang, by the pressure of the rising tooth. Now here we should suppose that the newly-formed tooth should be the most apt to be absorbed by the pressure of the root of the deciduous tooth, did we not recollect that the new tooth is invested with the hard enamel, while the pressure on the other acts upon the bony root. But there is more than this in the phenomenon of the shedding of the teeth, for often the fang is wasted while the tooth adheres only by the gum, and the permanent tooth has made little progress in its elevation, and has not pressed upon it. This decay and wasting of the fangs of the teeth looks more like a satisfactory proof in support of their vascularity, than any other change to which they are subject.

Yet there seems to be no reason why we should not suppose, that as the rudiments of the teeth rise into action at a particular time, and form the bony centre of the tooth, this formation should be affected by similar laws ; that at a particular period the tooth should decay, and that the decay of the tooth should begin with the destruction of the fangs. Neither can I resist the belief that the bony part of the tooth has a tendency to dissolution independently of a circulation of blood through it, or of an internal action of vessels, and that as the roots waste, the surrounding vascular parts absorb its substance.

It is no proof of the first set being pushed out by the second set of teeth, that if the permanent teeth do not rise, the first will remain, their roots unwasted and firm even to old age ; for still I contend that there is an agreement and coincidence betwixt the teeth in their changes, and also in the alveoli, by which they are surrounded ; but this is not produced by the pressure of the rising teeth. When a dentist sees a tooth seated out of the proper line, and draws it, and finds that he has made the mistake of extracting the adult tooth, letting the milk tooth remain, he must not expect that the milk tooth will keep its place, for the contrary will happen, it will in general fall out.

The old and the new teeth are lodged in distinct compartments of the jaw-bone, and what is more curious, their alveoli are distinct, for as the roots of the first teeth decay, their alveolar processes are absorbed, while again, as the new teeth rise from their deep seat in the jaw-bone, they are ac-

companied with new alveoli*; yet these alveoli are not sufficient to support the teeth, for we find that the teeth will remain long perfect while they uniformly retain their relative position and number, but when one falls, the rest more quickly decay; and the chief art of the dentist in shifting the seat of the teeth, is gradually to push them along the jaw notwithstanding these bony partitions and processes, so as to bring them into equal and seemly lines.

No circumstance can better illustrate how perfect the dependence of the alveoli is upon the teeth, than that of their being thrown off with them in extensive exfoliations. I have a specimen of this in my collection, where the whole circle of the alveolar processes and teeth is thrown off. This happened after the confluent small-pox. I think I recollect a similar case occurring to Dr. Blake. In those tumours which arise from the alveoli and gums, filling the mouth with a cancerous mass, and softening the upper part of the jaw, there is no eradicating the disease but by taking away the whole adventitious part of the jaw which belongs to the teeth, and leaving only the firmer base. But even this operation will be too often unsuccessful.

When a tooth is lost, it appears as if the space it occupied were partly filled up by an increased thickness of the adjacent teeth, and partly by the lengthening of that which is opposite: indeed, this appearance has been brought as a proof of the continual growth of teeth. But there is a fallacy in the observation; for when the space appears to have become narrow by the approximation of the two adjacent teeth, it is not owing to any increase of their breadth, but to their moving from that side where they are well supported to the other side where they are not. For this reason they get an inclined direction; and this inclination may be observed in several of the adjoining teeth†.

The transplanting of teeth presents another very interesting phenomenon. A tooth recently drawn, and placed accurately into a socket from which one has been taken, will adhere there: nay, it will even adhere to any living part, as in the comb of a cock. This, however, proves nothing further than what all allow, that the tooth possesses vitality, for after a time it will not adhere; it has become a dead part, and the living substance refuses to coalesce with it. Again, and in opposition to this, is it not very extraordinary that the teeth may be burnt by chemical agents, or the actual cautery, down to the

* Mr. Hunter.
† Mr. J. Hunter.

centre, and yet retain their hold; or that the body of the tooth may be cut off, and a new tooth fixed into it by a pivot? Had the teeth any vascular action, this torturing would cause re-action and disease in them. Sometimes the most terrible effects are produced by these operations, as tetanus, abscess in the jaws, &c.; but this happens in consequence of the central nerve being bruised by the wedging of the pivot in the cavity of the tooth, or by the roots of the teeth becoming, as dead bodies, a source of irritation to the surrounding sockets.

The disease produced by the transplanting of teeth has not been satisfactorily explained, though the investigation would throw considerable light on the physiology of the teeth, and be in itself of practical use.

About a month after transplanting the tooth, and after it has taken perfect adhesion, the disease has appeared. An ulceration is perceived in the gum and jaw; or the gum shrinking and wasting by ulceration, leaves the tooth and alveoli bare. Soon after, blotches appear on the skin; and sometimes ulcers in the throat.—In some cases, this disease has been cured without mercury, and in others, seems only to have yielded to the mercurial course. Mr. Hunter entertained the opinion that it was not venereal, but a distinct disease; and I find that Richter supposes there are two diseases produced, the one venereal, and the other a peculiar affection. Others have supposed that this is not a disease propagated from the one person to the other, but produced by the combination of the living principle of two distinct systems! In short, the case does not seem to be well understood. Supposing it to be the venereal disease thus propagated, (and this is the most likely suggestion,) then it does not appear that we should consider it as an inoculation of the matter of the disease, but of a part long contaminated, ingrafted: and in this view it will probably be found necessary to continue the plan of cure as for an old affection, and not for the recent disease.

We may conclude that the teeth are peculiar in their substance and structure, in the manner of their growth and nutrition; and, as they are distinct from the other bones of the system in their form and connections, so are they in their more essential qualities.

Of the gums.—The necks of teeth are surrounded by the gums, a red, vascular, but firm substance which covers the alveolar processes. To the bone and to the teeth the gums adhere very strongly, but the edge touching the teeth is loose. The gums have little sensibility in their healthy and sound state; and by mastication, when the teeth are lost, they gain a degree of hardness which proves almost a substitute for the teeth.

The use of the gum is chiefly to give firmness to the teeth, and at the same time, as Mr. Hunter observes, to give them that kind of support which breaks the jar of bony contact. Like the alveolar process, the gums have a secret connection with the state of the teeth. Before the milk-teeth appear, there is a firm ridge which runs along the gums*, but this is thrown off, or wastes with the rising of the teeth: and as the teeth rise the proper gums grow, and embrace them firmly. The gum is firm, and in close adhesion, when the teeth are healthy; loose, spongy, or shrunk, when they are diseased. The only means of operating upon the general state of the teeth is through the gums; and by keeping them in a state of healthy action by the brush and tinctures, the dentist fixes the teeth, and preserves them healthy; but when they are allowed to be loose and spongy, and subject to frequent bleeding, (which is improperly called a scorbutic state,) the teeth become loose, and the gums painful. If a healthy tooth be implanted in the jaw, the gum grows up around it, and adheres to it; but if it be dead or diseased, the gum ulcerates, loosens, and shrinks, from it; and this shrinking of the gums is soon followed by the absorption of the alveoli.

From the disorder of the teeth, the gums are subject to many diseases; some of them troublesome, some dangerous, or at least giving rise to dangerous diseases. They swell from tooth-ach and inflammation of the centre of the tooth (parulis), or form tumours from the side of the tooth (epulis). Often suppuration follows these swellings; and the matter making its way by the side of the jaw, and destroying the alveoli, troublesome fistulæ are the consequence. The accumulation of tartar on the teeth is the cause of an ulceration and wasting of the gums, in the end very injurious to the teeth. The soft, spongy, and bleeding tumours which arise from the gums, are in fact diseases of the bone, or rather the peculiar characteristic of the disease of the alveoli and of the cancelli of the jaw-bone; and cannot be cured but by a practice which reaches to the root and origin of the disease.

OF THE FIRST AND SECOND SET OF THE TEETH.

Before we observe the classing of the adult teeth, we must attend to the two sets of teeth, the infantine or deciduous teeth, and the adult or permanent teeth.

The first set of teeth are twenty in number: these are divided into three classes; the INCISORES, four in each jaw; the

* See Heriffant.

CUSPIDATI, two in each jaw; and the MOLARES, four in number in each jaw.

The teeth of a child generally appear in this order: first the central incisores of the lower jaw pierce the gum. In a month after, perhaps, their counterparts appear in the upper jaw. These, in a few weeks, are succeeded by the lateral incisores of the lower jaw; then the lateral incisores of the upper jaw. The growth of the teeth is not after this in a regular progression backwards, for now, instead of the cuspidati, which are immediately lateral to the incisores, the anterior molares of the lower jaw slowly lift their white surface above the gum about the fourteenth or fifteenth month. Now the cuspidati pierce the gum; and, lastly, the larger molares make their appearance, the teeth of the lower jaw preceding those above. The last tooth does not rise till the beginning of the third year.

The teeth do not always cut the gum in this order; it is only the more regular and common order. When the teeth appear in irregular succession, more irritation and pain, and more of those symptoms which are usually attributed to teething, are said to accompany them, an opinion which I believe to have arisen from some casual observations.

The deciduous set of teeth terminates with the rising of the second molaris; for the third molaris being formed about the eighth year, when the jaw is advanced towards its perfect form, is not shed, but is truly the first permanent tooth. The molares of the adult are properly the permanent teeth (IMMUTABILES), for all the others are deciduous, and are replaced by the adult set; yet we must recollect that, in opposition to Albinus, in this arrangement, it is more common to speak of the whole set of the adult teeth as the *immutabiles*.

In the sixth and seventh years the jaws have so much enlarged, that the first set of teeth seems too small, spaces are left betwixt them, and they begin to fall out, giving place to the adult teeth. But the shedding of the teeth is by no means regular in regard to time; the child is already no longer in a state of nature, and a thousand circumstances have secretly affected the health and growth. The teeth even fall out three years earlier in one child than in another: nay, so frequently are some of them retained altogether, that it would appear necessary to be assured of the forward state of the adult tooth before the tooth of the first set should be thoughtlessly drawn.

The jaw-bones are still so small, that the second set of teeth must rise slowly and in succession, else they would be accumulated into too small a circle, and of course turned from their proper direction.

The incisores of the under jaw are loose commonly when the anterior of the permanent molares are thrusting up the gum. The permanent central incisores soon after appear, and in two or three months those of the upper jaw appear. In three or four months more the lateral incisores of the lower jaw are loosened, and the permanent teeth appear at the same time the anterior molares have appeared. The lateral incisores of the upper jaw follow next; and, in from six to twelve months more, the temporary molares loosen, the long fangs of the cuspidati retaining their hold some time longer.

The anterior molares and the cuspidati falling, are succeeded about the ninth year by the second bicuspides and the cuspidati. The posterior bicuspides take the place of the posterior molares about the tenth or eleventh year. The second permanent molares do not appear for five or six years from the commencement of the appearance of the permanent teeth. The last of the molares, or the dens sapientiæ, appears from the fifteenth to the twentieth, or even to the twenty-fifth year.

CLASSES OF THE ADULT TEETH.

The teeth at full maturity are thirty-two in number*, and they are divided into these classes, *incisores*, *cuspidati*, *bicuspidi*, and *molares*.

The incisores are eight in number, four in each jaw: they are of the simplest form, their edges are even, and laterally they contract equally to the neck: they are gibbous, forward, and slightly concave on the inside; their roots are simple. The incisores of the upper jaw are larger and stronger; those of the lower jaw are smaller, neater, and for the most part evenly set, while the teeth of the upper jaw are more frequently irregular from being crowded together.

The cuspidati† are four in number, one lateral to the incisores of each jaw. They are stronger than the last in their form; thicker at their base: in the gum more convex forward, and terminate with a notched central point. In general, and particularly in the lower jaw, they project further than the other teeth; their roots are single and long; they stand betwixt the incisores and grinders in form as in place, for they seem neither perfectly adapted to cut like the incisores, nor for grinding. "We may trace in these teeth," says Mr. Hunter,

* From twenty-eight to thirty-two in number.—Hunter.

† *Dentes canini*, the eye-teeth, from their place of original lodgment in the upper jaw.

" a similarity in shape, situation, and use, from the most imperfect carnivorous animal which we believe to be the human species, to the most perfect carnivorous animal, the lion."

Next in order from the symphysis of the jaw rise the bicuspides, the fourth and fifth teeth. These are eight in number, and accurately resemble each other. Taking one, we may observe that it is flattened laterally, answering to the flat side of the root, and that it terminates in two acute points: the internal of these points, even when not worn down, is the least. The second bicuspes is often wanting. The bicuspides are very often called the anterior grinders. Their roots are single, or appear like two fangs united; or the first bicuspes has in general two small fangs, or is rather forked; the others seldom more than one. Their roots are oftener curved than those of the other teeth.

The first and second grinders are nearly alike. The body of these forms almost a square; generally five points project from their grinding surface, which makes an irregular cavity in the centre: often some lesser tubercles, or points, are to be observed at the base of the larger ones. The neck of the tooth is but little contracted. There are two fangs, one forward, the other backward, with their edges turned outward; their extremities are broad, often bifurcated, and shorter than those of the bicuspides. There are two cavities to each fang leading to the general cavity in the body of the tooth. The fangs at their middle part are generally bent a little backward. The upper grinders have three diverging fangs, and they are more pointed, and have but one canal. They are directly under the floor of the maxillary sinus.

The jaw acquires its full proportion about the age of eighteen or twenty, when the third molaris, or the *dens sapientiæ*, makes its appearance. It is shorter and smaller, and is inclined more inward than the others. Its fangs are less regular and distinct, being often squeezed together. From the cuspidati to the last grinder, the fangs are becoming much shorter; and from the first incisor to the last grinder, the teeth stand less out from the sockets and gums.

FINIS.